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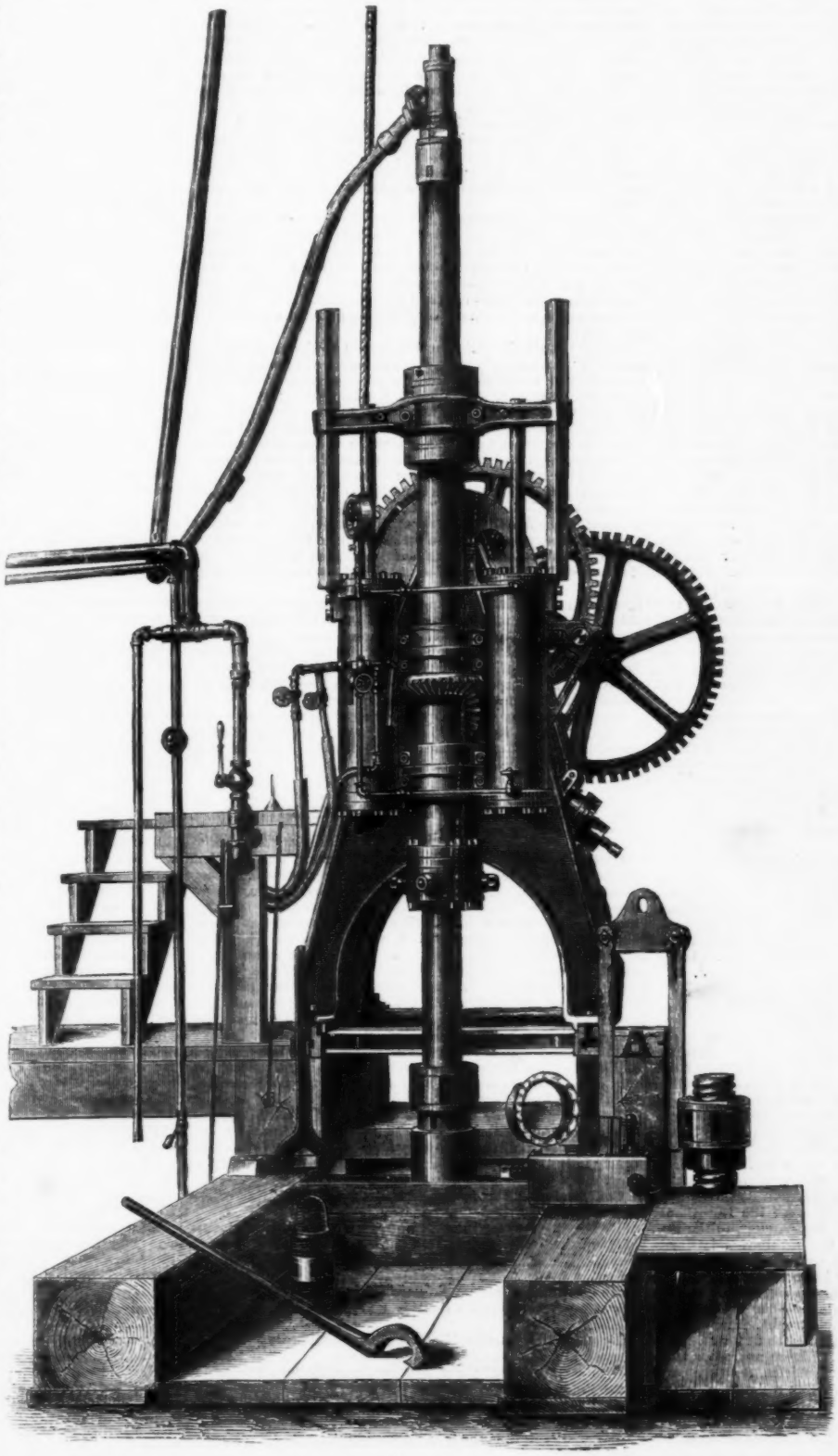
THE PENNSYLVANIA DIAMOND DRILL COMPANY'S DRILL.

THE core is lifted by a shell or thimble of the same size and shape as a core bit, and indeed may be combined with the same, being simply a recess in the inside of the thimble, composing the bit or core lifter, about 1 inch in width, bevelling inwards and downwards, towards, and coming within about 1⅛ inch of the face or lower end of the bit or core lifter. In this recess is placed, loosely, a tempered open steel spring, about ½ inch wide, with three, five, or more vertical ribs to give the proper thickness, which may be armed on the inside with diamonds, to keep it from being worn by the core, and which, when the drill is descending, is pushed by the core up into the deep part of the recess, where it has no effect; but when ascending, slides down on the bevelled sides of the recess which contracts it firmly against the core, which it carries with it to the surface. The drill is rotated by one of J. B. Root's "square" engines, of very peculiar form, and the feed is regulated by two hydraulic rams placed on each side of the rods, connected to a crosshead, shown very clearly on the photograph, by which a very equable and yielding feed is obtained. The crown is attached to the end of a wrought-iron tube from 8 to 12 feet long, the size of the hole intended to be bored, set with diamonds at intervals, to prevent it from wearing, and provided its full length with spiral grooves, to allow egress for the water and sediment on the way up to the top of the bore hole. The tubular boring-rods are attached by means of a derrick above the machine as the depth of the hole increases, the flexible water tube being attached to the top of each rod as it is fixed. This enables the base of the machine to be fixed close to the ground, giving it great stability. The largest hole yet bored with this machine has a diameter of 9 inches and a depth of 357 feet. The deepest hole is 1000 feet from the surface. A new form of diamond quarry drill is shown by the same company, provided with a new friction-feed motion and driven by one of Lidgerwood's rotary engines. It is very compact and light, only weighing 350 lbs. —*Engineer.*



THE INTERNATIONAL EXHIBITION OF 1876.—THE PENNSYLVANIA DIAMOMD DRILL COMPANY'S DRILL.

BREWERS' HALL AT THE CENTENNIAL.

THE exhibits displayed in Brewers' Hall are notable for their completeness; every product, both agricultural and manufactured, which finds a place in a brewery is here well represented. Weil, Bacher & Loewi display samples of hops from Sussex, and five varieties from Kent, England, including the celebrated Farnhams. Their exhibit also includes samples of hops from New-York and California, as well as numerous samples of German growth. Among the numerous samples of barley exhibited, that from Chevalier, California, and the Moravian take the foremost rank. W. Orth, of 181 Prince street, New-York, exhibits a copper kettle of a capacity of 150 barrels, which has several noteworthy features. It is provided with an eye-glass through which the operator can watch the boiling process, which must, when it has once begun, be kept in continuous progress. The eye-glass is ⅝ inch thick and about 8 inches in diameter. This copper is a very neat and creditable piece of workmanship, and is shown in connection with a complete brewing apparatus, including vats and steam pumps.

Charles Stone, of 222 Merserole street, Brooklyn, exhibits a malt-mill and screen combined, notable for a simple arrangement whereby the crushing rollers can be taken out to be turned up in case of their becoming damaged, as such rollers occasionally do, without disturbing any other part of the mill. A plate of glass is also inserted above the rollers to enable the operator to observe how the grain is feeding. The capacity of this mill is about 300 bushels per hour. Another mill, by the same exhibitor, is not provided with any screen, the idea being to place the screen in any convenient place about the brewery and to then spout down to the mill. A malt-scourer, among the same exhibits, has a capacity of 500 bushels per hour. From a model exhibited by Mr. Stone we are initiated into the mysteries of brewing as follows. At the top of the building stands the malt tower or reservoir, which is divided into two compartments by a partition running through its vertical centre, the object being to have at hand and ready for use two kinds of malt. By opening a gate or trap the malt is allowed to fall into a hopper, whence, after the previous gate is closed, it is allowed to pass through a second gate, operated by a lever arrangement, into the weighing hopper, which stands upon the weighing scales. From here, after being weighed, it passes to the elevator and is conveyed up stairs to the malt mill, where it is ground, and from whence it passes to the ground-malt bin. From this bin it is conveyed by spouts to the mash tub, where it is mixed with the hot water, a circulation being kept up by mechanical mixers. From the mash tub the liquor is drawn off and run into the beer kettle, where it meets the hops, and where it is boiled for about 4 hours, after which the whole mixture passes to the hop jack, where the hops remain while the liquor is drawn off into a large flat pan called the surface cooler. From the pan it is conveyed to the cooling apparatus, which is composed of a series of horizontal pipes standing one vertically over the other, and the whole of them filled with ice water. The beer is supplied to the outside of the pipes in quantities sufficiently small and with a sufficiently even supply to ensure that it dripples and does not flow over them; and to facilitate the dripping, the pipes have running along their underneath side small projections, like teeth, down which the liquor trickles and leaves the points in form of drops, which is done to ensure the rapid cooling of the liquor. From here the beer passes to the fermenting tubs, where self-fermentation takes place, and the yeast forms both on the top and at the bottom of the tubs; that on the top, being useless, is skimmed off, while that which forms on the bottom is the yeast used in bread-making and for culinary purposes. From the fermenting tubs the beer passes to hogsheads of a capacity of about 40 barrels each, where, by leaving the bungs out of the hogsheads, self-fermentation is again induced. From here it is run into other large casks which contain birch shavings, which act to clarify the beer, and it then only remains to barrel or keg the beer ready for the market. J. R.

VALVELESS ENGINES AT THE CENTENNIAL.

THERE are in Machinery Hall at the Centennial three valveless engines—one is exhibited in the Russian, one in the English, and one in the American departments. In each of these engines the steam passes from a steam port in the cylinder into the piston head without the intervention of any valve arrangement whatever, the pistons being given a reciprocating semi-rotary motion, so that the position of the passages in the piston head, relatively to the position of the steam port in the cylinder, serves to admit and cut off the supply of steam automatically. The exhaust of the steam is in each engine accomplished by a similar arrangement of passages. The engine in the American Department is exhibited by George J. Wardwell, of Rutland, Vermont, who is the inventor. It is an horizontal engine having a girder frame bolted to the cylinder head at one end, and to the pillow block at the other end. The pillow-block brasses are provided with side-adjustment wedges, operated from the top face of the cap by bolts and nuts. The steam cylinder is of 8 inches bore, the length of the stroke being 16 inches. The crosshead has its V-shaped bearings top and bottom, with a gudgeon, providing journal-bearing for the fork end of the connecting rod; the straps at these ends of the rod being provided with the ordinary jibs and keys. At the crank-pin end, however, the strap is secured to the rod by a bolt passing through the ties, the key merely serving to adjust the brasses, and not to secure the

strap to the rod—an arrangement which is much superior to the jib and key.

The piston-rod passes a working fit through the crosshead, being securely retained by a nut and check-nut at each end of the crosshead. This arrangement prevents any lateral play of the piston-rod in the crosshead, but at the same time permits the rod to rotate in the latter.

To the extreme end of the piston-rod, after it has passed through the crosshead, there is keyed fast a section of a bevel wheel, containing 5 teeth, which gears into a section of a bevel gear containing 4 teeth; this latter section being bolted fast to the inside of one of the fork arms of the connecting rod, the outside fork arm is the one selected, so as to place the arrangement in a position easy to get at in putting it together or taking it apart when necessary. If then we connect the connecting rod at the fork end, leaving the crank-pin end disconnected from the crank pin, and then move the latter end up and down, the two sections of gear wheels will operate to revolve the piston back and forth in unison with the up or down motion of the rod, without moving the piston along the cylinder at all. When, however, the connecting rod is connected at both ends, this semi-rotating movement takes place in regular order as the stroke proceeds, and it becomes possible to so arrange the steam passages that steam shall be admitted, cut off, and exhausted at any desired point of the stroke. It is obvious, however, that the piston head requires to be longer than is the stroke of the engine, and it is in the engine under consideration 19 inches, or 3 inches longer than the stroke.

The piston is solid, similar to a plunger, and is a neat working fit in the bore of the cylinder. The wear is provided for by the insertion, at each end of the piston-head, of ordinary spring packing rings, and to take up the wear and prevent leakage from one port to the other, a straight longitudinal spring packing piece is placed between the steam passages in the piston head, thus preventing the escape from one port to the other, even though the piston had suffered considerably from wear.

The steam port is in the centre of the cylinder and on the top; it is 3 inches long and 4 inch wide; the exhaust port being diametrically opposite and 3 by 1 inches. The steam passages in the piston head commence near one end, and run along the circumferential surface in a longitudinal but curved line, so that the passage will remain full open to the cylinder steam port notwithstanding the rotatory movement of the piston; at such part of the stroke, however, as it is determined to cut off the steam supply, the steam passage turns at an angle, and runs around nearly one half of the perimeter of the piston head, so that the rotatory motion of the piston during the remainder of the stroke is insufficient to permit any communication between the cylinder port and piston passage. So soon as the piston head steam passage turns the angle above noted, the longitudinal movement of the piston head past the cylinder steam port cuts off the supply of steam, and the remainder of the piston stroke is performed under expansive steam. The circumferential direction of the steam passage, above referred to, serves another purpose than acting as a cut-off in that it enables the same passage to be used to convey the steam to the cylinder exhaust port. After the steam passage has taken the circumferential direction referred to, it continues longitudinally to the end of the piston head, and upon the latter arriving at the end of the stroke, the steam passage, while isolated from the cylinder steam port, comes into open communication with the cylinder exhaust port, and that stroke of the engine is completed. For the return stroke a similarly-arranged steam passage is provided in the piston head, and hence the piston requires but two passages, each of which operates alternately as induction and eduction passages. In other engines of this class separate passages are necessary for the live steam and exhaust, and as a consequence there is an exhaust passage to be filled at each end of the stroke with live steam, from which no useful effect whatever is obtained.

A diagram taken from the engine in Machinery Hall shows the steam line to be quite perfect, the expansion curve being unusually regular, and even the exhaust quick and scarcely the thickness of a line above the air line, the compression line slightly rounded on corner. The diagram, taken while a friction brake was applied to the 5-foot fly-wheel, reads as follows: Steam pressure, 50 lbs. Average pressure with steam supply cut off at half the length of the stroke, 37 ⅞. Indicated horse-power, 10⅝.

The piston speed when the above card was taken was 140 double strokes or about 186 feet per minute, whereas the intended speed is 300 feet per minute. A friction card taken with the engine running light, that is under no applied load, reads: Revolutions, 70. Average pressure, 6.6 lbs. per inch Friction, 1.87 horse-power. There is no extra finish about this engine, but its various parts are substantial and well fitted.

J. R.

THE PHILADELPHIA EXHIBITION.

THE GOVERNMENT BUILDING.

The contents of the building devoted to the exhibits of the United States Government possess far more general and special interest than any to be found in any other similar area throughout the Exhibition, and we may say, perhaps, that no such interesting exhibits have ever before been collected into so small a space. Whether we turn to the Smithsonian collection—a magnificent metallurgical display, besides the show of building materials—to the contributions from the Patent Office—a vast and representative show of models of inventions selected from the great magazines at Washington; whether we turn to the exhibits of the Lighthouse Board, to that of the Meteorological Department, to the Post Office, in full activity conducting the Exhibition business, which is no sinecure, or whether we examine the exhibits of the Army and Navy Bureaux, the interest never flags, the value of the respective exhibits is always striking. Besides these there are objects of minor interest—the collection of food fishes, comprising specimens, photographs, drawings, and casts of all the varieties of fish recognized as fit for food, and different appliances for taking them. There are, too, a large number of relics of the stone age in America, represented by flint instruments and the like; there is a series of photographs taken by Captain Powell in his recent Colorado expedition; there are the Washington and other historical relics which always command a crowd, and a number of minor objects to which we need not refer. But the two most interesting sections are those of the Army and Navy Bureaux. And these, besides being so attractive, are models of arrangement and organization, and reflect the highest credit on the officers by whom the active work has been conducted—Lieut. Metcalfe in the one department, and Lieut. Thomas in the other. In the army section are exhibited a number of military curiosities, comprising uniforms and old weapons. Among these latter may be noticed part of a bronze breechloader sent from New Orleans, and to which the date of 1570 is ascribed, its origin being traced to some of the early Spanish invaders of America. It is of the form shown in the sketch, where it

will be seen that the breech of the gun is cut away on the upper side. The breech block is missing. It was probably cylindrical, and was locked by a key passing through a square slot in the under side of the breech. Besides this relic there are several old Spanish guns, part of those known as the Twelve Apostles, and which were brought to Louisiana by the Spaniards during the early period of their occupation of that country. Coming to later times, there are some beautiful specimens of bronze guns presented by Lafayette to the country during the revolutionary period.

Of the show of modern guns we shall speak again in detail, and so need only say here that the display is one most highly creditable to the department, considering the financial straits in which it is always situated. The heavy guns are all outside the building, several of them mounted upon their respective carriages or slung for transport.

Some very beautiful models are also shown, one of them representing the plant necessary for the production of the Hitchcock gun, which is built up of discs welded together. The manufacture of the Woodbridge gun is also illustrated by beautifully-made models. One of these shows the method of laying the wire around the steel core, this wire being brought to the gun from twelve drums, and wrapped around it with varying angles so that it might offer equal resistance to strain in every direction. The second model represents the mode of heating the gun and soldering the wire together. Samples of the steel and the cast-iron employed are also shown, as well as the blooms from which the discs of the Hitchcock gun are made.

The exhibition of small arms is very extensive, and comprises the leading varieties manufactured at Springfield, together with their ammunition, illustrated by cartridges shown in section, while the selection of cartridge and gun machines from Springfield attract always a large number of people.

In the Naval Department the collection of torpedoes is of considerable interest, and there is a large display of fuses, shot, shell, etc., for the naval service. All the arms used on board ship are also represented, from Gatling guns to handspikes. Outside the building are a small number of ships' guns, but none of them of great size or of novel construction. The carriages upon which they are mounted are of the old patterns.

A very beautiful exhibit in this section is the model of the war-ship "Antietam." It is 48 feet in length and 23 feet in extreme height, and is altogether a marvel of completeness and good workmanship. It is used for instructing the naval cadets in various points of seamanship, and as every brace and block throughout the model is in its proper place, and made to the proper scale, the practical value of the model is very considerable. Close behind it is a smaller model of the same vessel on the stocks, showing the framing and mode of construction. And near there is a curious old Spanish model of a Spanish ship—the "Dante" of 1620—which forms a striking contrast to the fine lines and rig of the "Antietam." In another part of this section are seen a series of cases full of representative ships' stores. Charts and instruments of all kinds, clothing and uniforms, provisions, ships' stationery, bedding, hospital fittings, surgical appliances, instruments, etc., all are there with a completeness and order of arrangement that enables one to gain a thorough insight into the system upon which the Naval Bureau at Washington works.

Almost of equal interest is the exhibit of the Lighthouse Board and that of the Meteorological Department, but of these we will not speak in detail now, as they will form the subjects of special articles hereafter.

Finally, we may give a passing word to the Post Office section, in which, as we said before, under the inspection of the visitors, the whole of the postal business connected with the Exhibition is performed.—*Engineering.*

ANILINE COLORS AT THE EXHIBITION.

By Carl Rumpff.

One of the most attractive exhibits among the chemical products of the German section of the International Exposition at Philadelphia, is a case contributed by Messrs. Friedr. Bayer & Co., of Barmen and Elberfeld, containing a large number of specimens illustrating the history, development, and processes of manufacture of the aniline colors. The works of this company employ the services of 268 workmen, and produce 7000 lbs. of alizarine, and 600 lbs. of the various aniline colors daily. The daily consumption of raw materials is as follows: Sulphuric acid, 154 carboys; muriatic acid, 100 carboys; anhydrous sulphuric acid, 1200 lbs.; bichromate of potassium, 2700 lbs.; caustic soda (70 per cent), 8000 lbs.

Messrs. Bayer & Co. have, in explanation of their exhibit at Philadelphia, issued a neat pamphlet, giving a concise history of the various steps of manufacture of the aniline colors, from which the following account is taken:

By the dry distillation (without access of air) of coal, two accessory products are formed, *coke* (deposit of retort) and *coal tar*. The ammoniacal waters which are obtained have recently been largely used for the manufacturing of spirit of ammonia, and the different salts of ammonia.

Coal tar forms the starting-point for all the aniline colors, and also for alizarine.

By heating coal tar in cast-iron retorts up to a temperature of 180 Centigrade, there result successively *Benzole, Toluole, Cumole, Xylole.* The last two hydrocarbons possess only a scientific interest.

By treating the above fluids with strong nitric acid at a low temperature, *Nitro-Benzole* and *Nitro-Toluole* are obtained.

By employing more acid and a higher temperature, *Binitro-Benzole* and *Binitro-Toluole* are produced.

The conversion of these nitro-compounds into the amido compounds—namely: *Aniline Oil* and *Toluidine*, is effected by agitating them for a time with acetic acid and iron borings, in the proportion of about equal weights, and then separating, through distillation, the aniline or toluidine from the excess of iron borings.

According to a report delivered by Koechlin to the Parisian Academy, the honor of the discovery of aniline red or fuchsine, is due to Professor A. W. Hofmann, formerly of London, now at Berlin, who, in 1857, first described the effect of tetrachloride of carbon on aniline.

Professor Hofmann, by further investigations, discovered that chemically pure aniline, as well as chemically pure toluidine, does not produce any red dye in a workable manner, but that a mixture of both does.

The proper proportion of the mixture, 1 part of aniline to 2 parts of toluidine, is sought to be attained as near as possible in the technical process for manufacturing the fuchsine. The best and most practical method is the following:

A mixture of aniline oil for red and arsenic acid diluted with water, is heated in a distilling apparatus from 10 to 12 hours, at a temperature of 180 to 190 Centigrade. The fused mass obtained in this way is broken into small pieces, boiled out with water; the undecomposed arsenic acid, as well as the arsenious acid which is formed, is neutralized with chalk, and immediately after the color is dissolved the liquor is filtered through felt into the crystallization vessels. After 3 to 4 days' cooling, the crystallization of the fuchsine has taken place, and the mother liquor is drained off.

The crystals, dried and freed from all dust, represent *Diamond Fuchsine.* The small crystals passed through a sieve, *Diamond Fuchsine* (*small crystals*). The non-crystallized part at the bottom of the crystallization tub is called *Fuchsine Red* (*ordinary*).

The basis of this peculiar dye, produced as above, Professor Hofmann has called *Rose-Aniline* (*Roscine base*), a name now generally adopted.

The combination of this base with any acid furnishes a number of salts; for instance: with acetic acid, *Acetate of Rose-Aniline.* The oxalate, sulphate, and nitrate of rose-aniline are of little importance for dyeing.

For the production of the pure base, the common acetate of rose-aniline is used with the most advantage.

About the year 1856, Perkins, in England, being occupied with experiments to produce artificial quinine, accidentally discovered a violet color, which, having been improved by one of the other chemists, was for a long time known in the market under the names of *Perkins' Violet, Aniline Purple, Phenamine, Indisine, etc.*

After red and violet had thus been discovered, and practically employed, endeavors were generally made for producing an aniline blue, to which exertions and experiments the different violets, as *Violet reddish, Violet medium shade, Violet bluish*, owe their origin, as the following method shows:

By heating a mixture of fuchsine and aniline oil (an addition of acetate of soda facilitates the reaction) 5 to 8 hours at a temperature of 150 to 160 Centigrade, the red color of the compound is gradually changed into violet. According to the desired shade, the fused mass is treated with acidulated water, the residue filtered and dried, and thus the above bluish-violets are obtained.

The case is different with regard to blue. If 1 part of fuchsine, 3 to 4 parts of aniline oil, and 1 part of acetate of soda are heated as above, the blue color is formed. By this process three equivalents of phenyle are taken up by the fuchsine, forming triphenyl-rose-aniline and ammonia which is given off.

The above fused mass treated with concentrated muriatic acid, and afterwards—according to the shade which is wanted—with alcohol, furnishes *Blue reddish shade* (*Bleu de Lyons*), *Night Blue, or Bleu de lumière.*

A great obstacle against a larger consumption of these blues was, their being insoluble in water.

Many experiments for their transformation at last led to a treatment analogous to the formation of the sulphate of indigo, and the process was a successful one by the following method: 1 part blue soluble in alcohol, is dissolved in 5 to 6 parts of common 66° sulphuric acid; the solution is heated to a temperature of 130 to 140 Centigrade; then the acid is neutralized with soda or potash, and the precipitate filtered and dried.

The sulphuric acid enters by this process into the blue, and forms aniline-blue sulphuric acid.

According to the more reddish or more greenish shade of the aniline blue which is converted, the product resulting is called *Blue reddish shade* (*Bleu de Lyons*) (*soluble in water*), *Pure Bluish* (*soluble in water*), *Pure Blue greenish* (*soluble in water*), *Night Blue or Bleu de lumière* (*soluble in water*).

If, instead of soda, lime salts are used for the neutralization of the sulphuric acid, the blues acquire the property of dyeing more easily on cotton and silk.

The blues mentioned so far, soluble in water, contain at least 2 equivalents of sulphuric acid. If the sulpho blue solution is heated only to 30 to 40 Centigrade, and then neutralized with soda or caustic lye, the mono-sulpho salt or alkali blue is produced—namely: Alkali Blue V B, Alkali Blue IV B, Alkali Blue III B, Alkali Blue II B, Alkali Blue I B.

The newest product in this branch is diphenylamine blue, which is distinguished by its pure greenish tone from all other aniline blues. It results by oxalic acid being heated with diphenylamine, which furnishes the first product, *Diphenylamine Blue* (*soluble in alcohol*).

The transformation into the corresponding blue, soluble in water, is effected in the same manner as with the other aniline blues, and gives *Diphenylamine Blue* (*soluble in water*).

Through further investigations, Professor Hofmann, by the action of *Iodide of Methyl* or *Iodide of Ethyl* on rose-aniline, discovered new violets, named after himself, *Hofmann Violets*, and shortly afterwards, the second important product in this direction—namely, the *Iodine Green.*

The above-named Hofmann's violets, on account of the so-far unattained beauty and brilliancy of their color, ruled the market completely for some years, until they by another step in advance were improved and surpassed in the following manner:

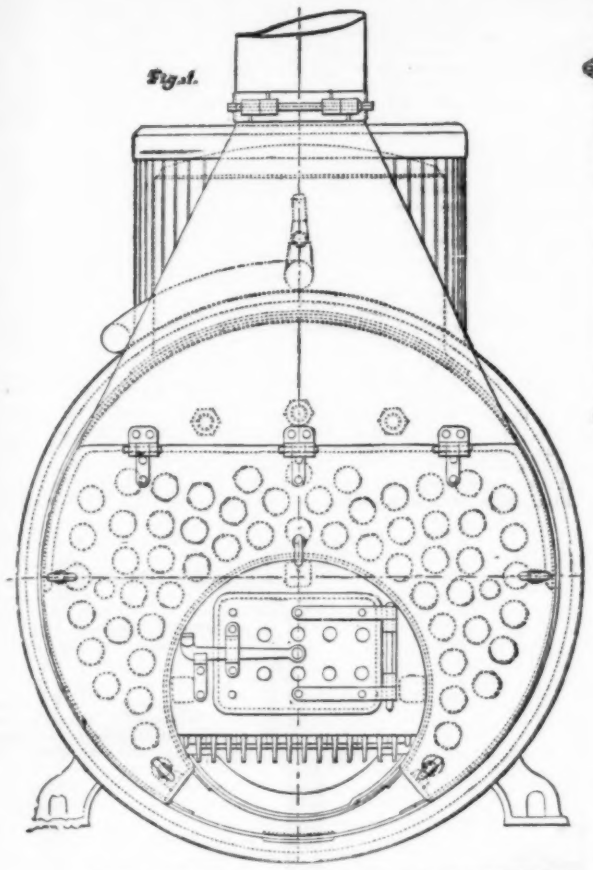
Muriate of aniline in crystals, when mixed with aniline oil and wood-naphtha, and exposed to a pressure of 50 atmospheres, at a temperature of 250 to 300 Centigrade, is converted into *dimethyl-aniline*, from which, through a simple oxidation, by the assistance of chlorate of potash or chloride of copper, the *Methyl Violet I B* is the result.

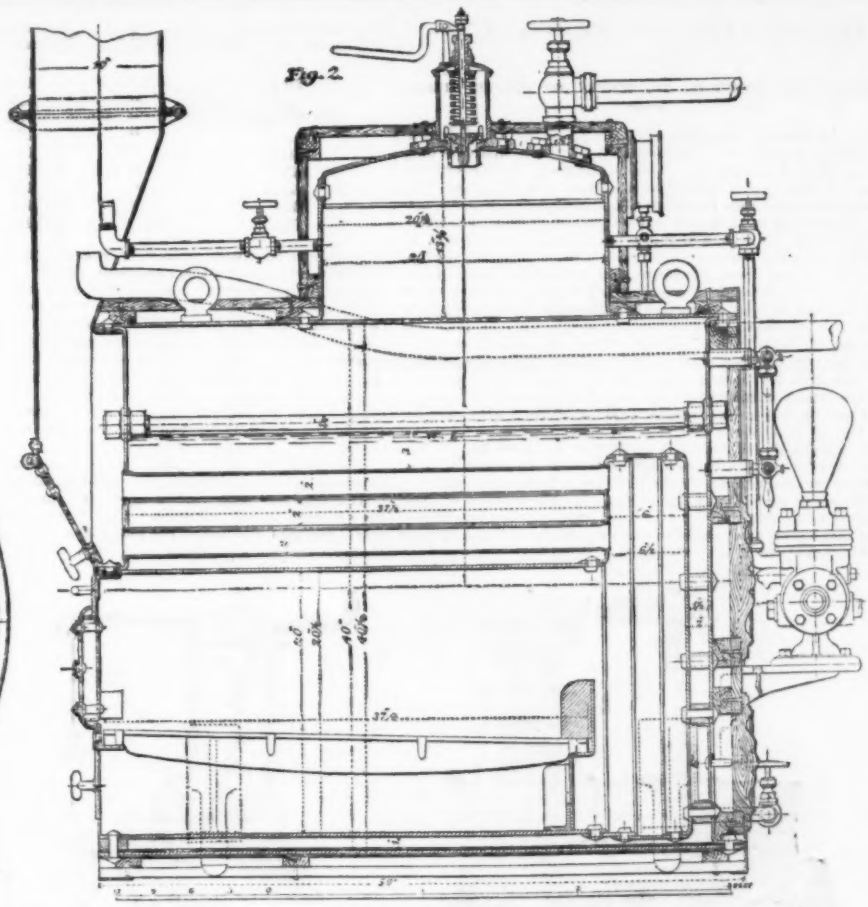
Through further treatment with chloride of benzole, produced by the action of chlorine gas on boiling toluole, the bluer shades are obtained; as, Methyl Violet II B, Methyl Violet III B, Methyl Violet IV B, Methyl Violet V B; and by treating them with iodine the redder shades are obtained—namely, Methyl Violet I R, Methyl Violet II R, Methyl Violet III R, Methyl Violet IV R.

In a similar manner as the iodine-violets were supplanted by the methyl violets, the iodine-green, formerly predominant, and, besides, the little known Chinese indigo, *Lao Cho*, the only color in existence for dyeing night-green shades, have been replaced by the Methyl Greens, which result from the process of making methyl violets: *Green yellowish, Green bluish.*

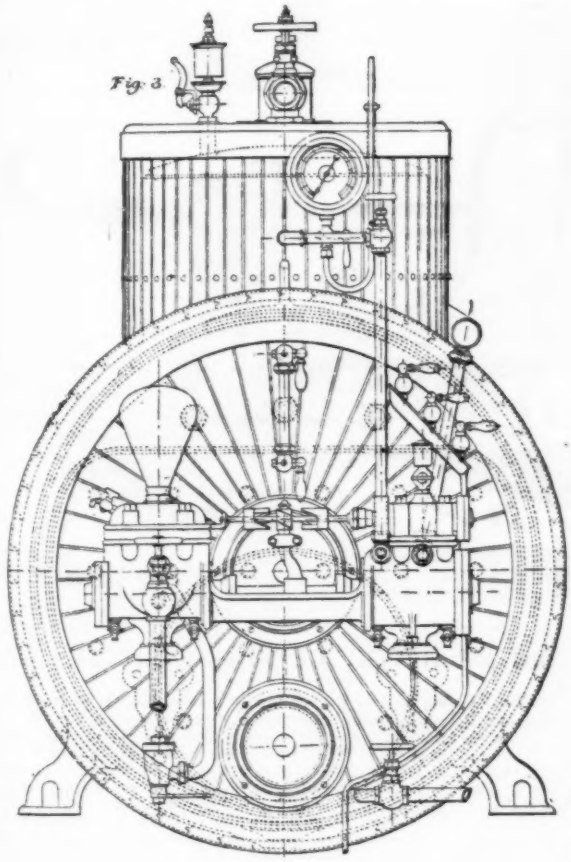
Chloride of aniline in cakes, generally called (as well as the chloride of aniline in crystals) *Aniline salt*, serves exclusively for the production of *Aniline Black*, which, by a mixture of it with other mordants, chlorate of potassium, sulphide of copper, etc., and gum or starch thickening, when printed on cotton, through a process of oxidation gives a black color, hitherto unknown in equal fastness, and, therefore, has become of the very greatest importance for all cotton print works.

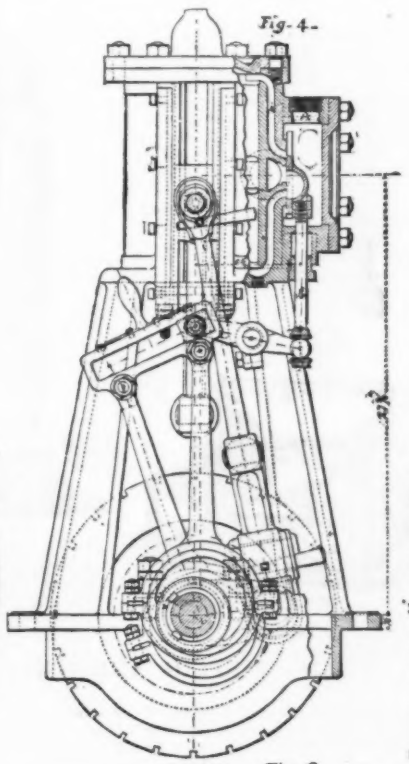
By introducing nitrous acid into Toluidine, and subsequent

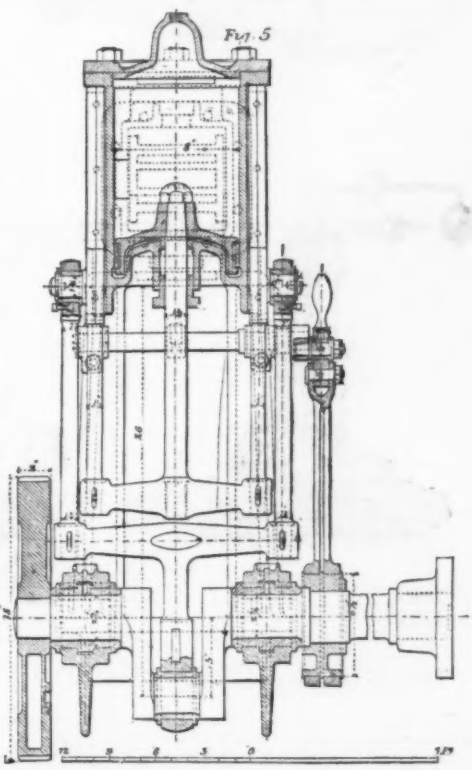


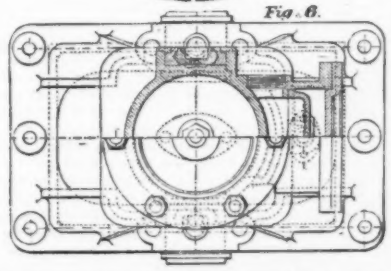


THE INTERNATIONAL EXHIBITION OF 1876.—BOILER AND ENGINE FOR NAVY CUTTERS.









oxidation by means of bichromate of potassium, there is formed another valuable color, the *Saffranine*.

Naphthaline, treated like benzole or toluole, as above mentioned, furnishes the nitro-naphthaline and naphtylamine, from the last of which by the action of nitric acid is produced the *Martius Yellow*.

Carbolic Acid likewise, produced by the distillation of coal tar, gives, when treated with oxalic acid, *Rosolic acid*, and this, under pressure, with ammonia, *Coralline*.

The newest and most beautiful child among the family of these dyes is the *Eosine*. It is also a product derived from benzole, and obtained by introducing bromine into fluoresceine, for which phtalic acid and resorcine are used.

Aniline Brown is a product of oxidation from nitro-benzole, and is generally known among the dyers by the name of Vesuvine, and considerably used; it dyes all shades of Havana browns.

By the action of nitric acid upon carbolic acid is produced *Picric Acid*, a yellow color, the consumption of which is great, especially for all green tints on wool, and in a chemically pure state gives two products in the trade, the acid in crystals and in amorphous powder.—*Laboratory*.

UNITED STATES NAVAL MACHINERY AT THE EXHIBITION.

AMONG the interesting exhibits of the United States Department at the Exhibition, the mechanisms employed in the Navy are quite notable. Our illustrations given herewith show an engine and boiler designed and constructed at the Washington Navy Yard, for boats of the cutter class having a length of 33 ft.; beam, 8 ft. 7 in.; depth, 3 ft. 9½ in.

The boiler is of the ordinary multitubular type, and consists of a shell 3 ft. 4½ in. in diameter outside, with a furnace 20½ in. in external diameter, all the plates of the shell and furnace (including the tube plates) being ¼ in. thick. The boiler is provided with 60 return tubes 3 ft. 1¼ in. long over tube plates, 58 of these tubes being 2 in. in diameter outside and the other two 1½ in. in diameter. The firegrate area is 4.5 square feet, and the total heating surface 125 square feet. A dome 20 in. in diameter, and 13¾ in. high, is fixed at the top of the boiler, and the latter is fed by a donkey pump bolted to it at the back end. The details of the boiler and its fittings are clearly explained by our engravings, and the weight of the boiler complete, as shown, is 2350 lbs. The general arrangement of the fittings is, as will be seen, very neat.

The cylinder is 8 inches, stroke 10 inches, and the engine weighs 725 lbs., the weight being rather heavy, owing to the somewhat singular arrangement adopted to obtain a long connecting-rod, and still keep the cylinder down tolerably close to the crankshaft. The present engine has a connecting-rod 26 in.—or 2.6 times the stroke—in length, and its height from centre of crankshaft to top of upper cylinder cover is 38 in. or 3.8 times the stroke.

As will be seen from Fig. 5, the piston-rod instead of being coupled direct to the connecting-rod, is screwed into a cross-head from which a pair of side rods extend upwards terminating in blocks working in guides formed at the sides of the cylinder. The connecting-rod is made with a wide fork, and takes hold of pins forged in one piece with the side rods and blocks just mentioned.

The link motion is used only for reversing and not for expansive working, the link being made with a straight slot, and provision being only made for fixing the block in extreme position by the arrangement shown. The valve is driven through the intervention of a rocking shaft and levers, and the remaining details will, we think, be readily understood from our engravings.—*Engineering*.

THE INTERNATIONAL EXHIBITION OF 1876.

No 21.

TESTING AND WEIGHING MACHINERY OF MESSRS. RIEHLE BROS.

In physical investigations the most important of all instruments is the balance. Quantity in matter is comparable only by its aid and indication. In metallurgy and the determination of the value and fitness of the various metals and alloys as components of different structures, the testing machine occupies a place similar to that of the balance in general physics. By means of it specimens of the metals may be subjected to the various stresses such as they are intended to sustain in the given structure, and the safety factor determined by it. The importance, therefore, of this machine in the arts can not be overestimated. Among the exhibitors in this line—both scales and testing machines—the brothers Riehlé, of Philadelphia, occupy a front rank in this country. The testing machine particularly has been made a specialty by this firm, and their productions in this line have an enviable reputation throughout the United States and Europe.

Their exhibition in Machinery Hall consists of four varieties of testing machines: one capable of stresses up to 150,000 lbs.; one to 40,000 lbs.; one to 300 lbs., and one to 100 lbs. The first two of these are adapted to test by either tensile, transverse or crushing strains, and may be used upon any material when made to the proper size to fit the machines. The firm supply cards showing the sizes necessary for specimens, and make tests daily, both at their establishment and at their exhibition space at the Centennial.

Tons indicated by Dead-Weight Levers.	Equal to	Tons indicated by Hydraulic Gauge.
50.625	"	105.
52.75	"	110.
54.25	"	115.
57.625	"	120.
59.75	"	125.
60.875	"	130.
63.	"	140.
65.75	"	150.
69.	"	160.
72.	"	170.

The above tests were made very carefully upon a good lever-testing machine and a good hydraulic gauge. The hydraulic jack and gauge were at one end of the testing machine, and the levers at the other end, the specimens being secured between, and the proper strain was weighed at intervals by means of the levers, whenever the gauge indicated an increased strain of 5 tons. These tests show how uncertain the results are when a hydraulic testing apparatus is used. When chains, wire rope, cables, and more especially iron columns, girders, etc., are required to stand a certain strain, it is of the utmost importance that the tests be made upon a lever machine.

The main lever of this machine, as represented in the engraving, and seen through the openings in the base, is very heavy, and has long "knife-edge" fulcrums resting evenly upon hardened steel bearings. This lever is kept in a horizontal position, and under the maximum motion of the weigh beam its motion is practically nil, from the great multiplication of lever, and from the first fulcrum of the main lever to the weighted end of the weigh beam. The weights are applied upon the scale pan suspended from the inner end of the weigh beam, and the indications for horizontality of the beam are read at the pointer attached to the frame. With this arrangement it is not possible to give to the specimen under test any undue or sudden strain, for the reason that the main lever is kept practically horizontal and motionless while it receives and transmits the great bulk of the strain. Some opposition has been made to the use of the hydraulic pump and piston as in this machine, on account of the motion of the weighted end of the weigh beam which occurs when the specimen is stretching just before fracture. This motion is, however, caused by the strain being in a measure removed by the successive disintegrations of the fibre or structure of the material, operating to produce recurring increase and decrease in the strain sustained by it until total fracture occurs.

The 40,000-lb. machine, in one variety, has a beam with travelling poise, which moves easily along on wheels, and which, with the small poise on the side beam, gives the whole capacity without extra weights. The quick and accurate results given by this machine are very satisfactory. Every known device has been tried upon it for the purpose of making an automatic indication of increase and decrease of strain, such as the flowing of shot into a receiver, clock-work, etc.; but all have the serious objection of extreme slowness, and it has been found better to move the poise rapidly or slowly by hand, as the conditions of the test should demand.

Another form of the 40,000-lb. machine for the application of tensile strain to round, flat, or square specimens, from 8 inches to 16 inches long, is shown in Fig. 2.

This machine operates exactly like those already described, except that it has no intermediate lever, and the specimen is strained downward instead of upward. The treadle is for the purpose of raising the hydraulic plunger back to its original position. The plunger in the first machine sinks of its own weight, while in this and the horizontal machine it is forced back by similar means. In Fig. 2 also the strains are measured and indicated by the accumulation of weights upon the rod suspended from the weigh beam, as shown.

The 100-lb. machine, seen in Fig. 3, is designed for testing twine and other articles of comparatively small resistance. For such small strain, the screw has been found well adapted, while being in this application much cheaper.

Probably no makers of testing machines, at least in this country, have devoted so much time and attention to this branch of manufacture as the Riehlé Bros., and their machines are to be found all over the world. There are about forty of them in use in the United States alone. They claim to be prepared to furnish machines for tensile, transverse, torsional, or compressive tests up to 1,000,000 lbs., or more if necessary.

In the other of their specialties, weighing scales, they make a quite extensive, and in many respects novel, display. They exhibit a self-adjusting railroad-track scale of 40 tons capacity, on which they have several marked improvements: All its bearings are made to rock, instead of being fixed, as is usual; it has extra long fulcrums, which are calculated to keep in a sharp condition for a long time. With this peculiar rocking construction of the bearings, the edges of the fulcrums can not break or crumble in case of shrinking or twisting of the timbers, or settling of the foundations, as in such contingencies the fulcrum continues to bear upon its whole length. The double beam of this scale appears to be a most excellent one, and for the following reasons: It has two large poises, and two small sliding poises running from one end to the other, and requiring no loose weights: the whole arrangement makes it possible—as is done with one of them in use on the Reading Railroad—of weighing cars while in motion. The balance ball, which can not turn of itself, is a marked improvement. The construction of this track scale seems to have been with the view of combining strength with accuracy of record, and certainly this has been successfully carried out. The levers are short and slightly arched from centre to side of scale, and swing with a free but strongly checked motion without danger of binding; the chairs are low, with a wide base, very strong and heavy, and directly sustain the greatest burden of the load immediately beneath the wheels, and are without the long and heavy centre levers found in some of this variety of scale. The light ends of levers are connected with the necessary bell-crank levers, and the whole is united with a centre-cord, which, after several years of discussion, is now admitted to be a decided improvement.

They exhibit a furnace-charging scale, having some excellent points: They have independent beams, and are not exposed in any way during the process of weighing. The poises in these scales have a notched pin that holds them in position instead of the usual set-screws, which are in many respects objectionable. The boxes of these scales are cast in one piece, and are exceedingly strong and durable; the tops are heavily ribbed, so as to insure them against fracture from falling pieces of metal.

They also show a very heavy and well-made rolling-mill scale (Fig. 4), of 12,000 lbs. capacity, with over a ton of material in it most judiciously distributed; it is well calculated for heavy work, and for keeping in an accurate condition for a long time.

Near the latter is a ten-ton wagon scale with net and tare beams, and having a peculiar motionless platform, made so

Fig. 4.

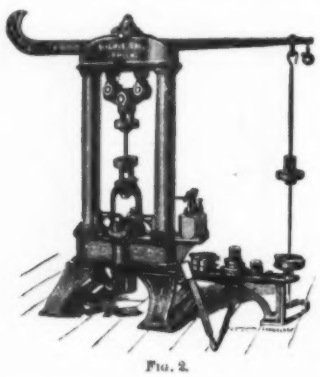


Fig. 2.

Fig. 5.

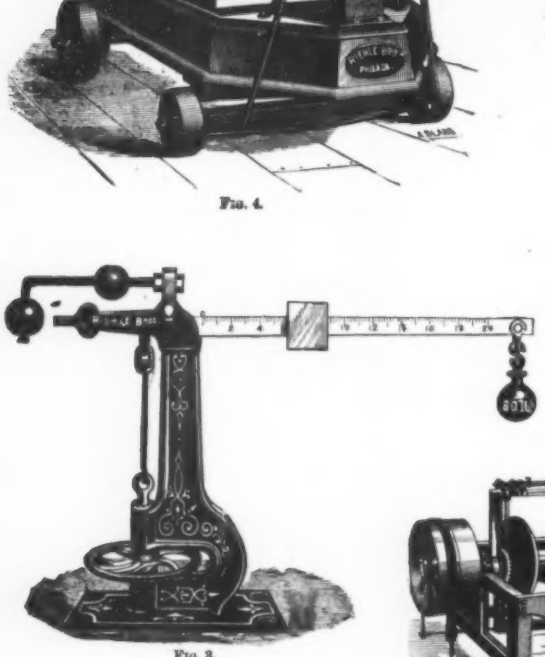


Fig. 3.

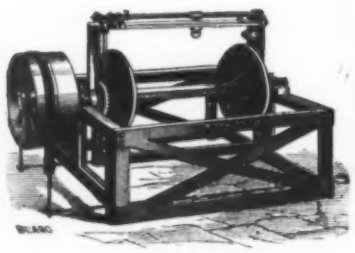


Fig. 6.

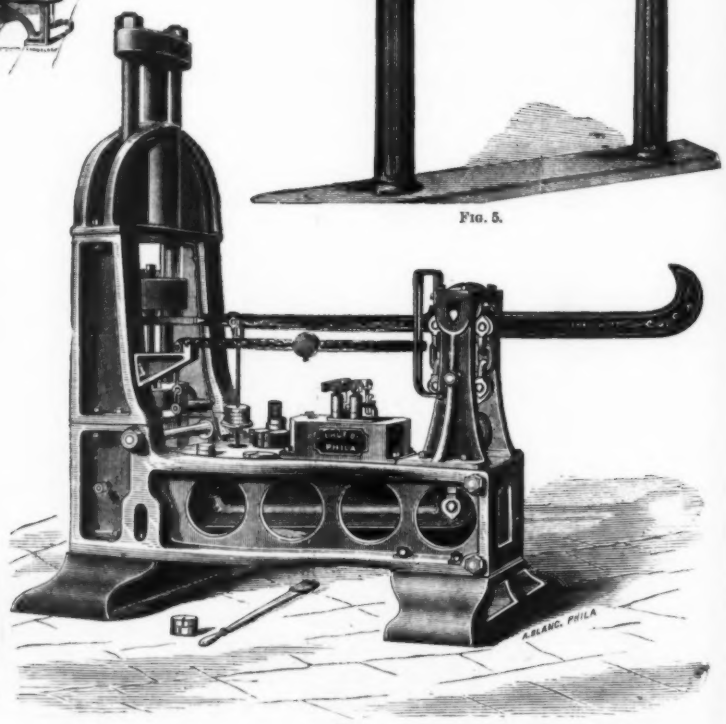


Fig. 1.

THE INTERNATIONAL EXHIBITION OF 1876.—TESTING AND WEIGHING MACHINERY OF MESSRS. RIEHLE BROS.

The smaller machines are for testing cement and small specimens of any kind of tensile strain only.

Fig. 1 shows the 150,000-lb. machine, on which, as well as on the 40,000-lb. machine, hydraulic power is used in preference to the screw as applied in older machines. The former is rapid and easily managed, and occupies but little room. No wheels or cogs are used, such as are indispensable in machines with screws. They are, however, made to transmit and indicate the hydraulic strains by means of levers instead of the hydraulic gauge. The unreliability of the latter is shown in the annexed table of results of experiments by J. P. Miner, Esq., superintendent of the Standard Chain Works, East Bridgewater, Mass., for Commander L. A. Beardsley, U.S.N., at the Navy Yard, Washington, D. C.:

Tons indicated by Dead-Weight Levers.	Equal to	Tons indicated by Hydraulic Gauge.
19.125	"	20.
22.625	"	25.
25.75	"	30.
28.25	"	35.
32.25	"	40.
34.75	"	45.
36.05	"	50.
39.125	"	55.
39.75	"	60.
41.125	"	65.
42.0625	"	70.
42.75	"	75.
43.875	"	80.
45.25	"	85.
46.375	"	90.
48.3125	"	95.
49.75	"	100.

by having the levers of the first order and supported on chairs, instead of being hung, as is ordinarily done. It is an admirable scale for weighing live-stock, is very sensitive and strong, and has, in common with the other heavy scales of this firm, the rocking, or self-adjusting bearings. This scale has many advantages over those which are constructed to hang from the corners of the foundations, and no trouble can arise from accumulation of ice or scum upon the links and levers, as all are covered and away from the edge of the platform.

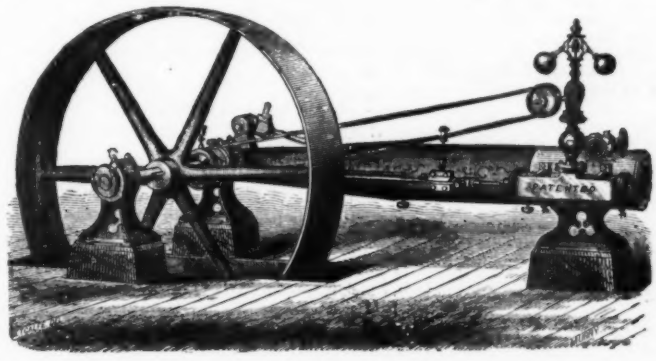
They also show the handy and powerful parallel crane beam, of which they were the originators, for ascertaining the weight of heavy bodies as swung from a crane.

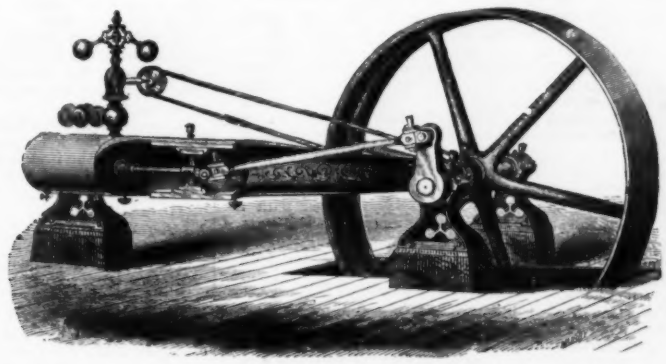
Fig. 5 represents a simple but very useful and important improvement in beams for wagon or other scales, indicating net or tare weight. They are designed for windows where the light, being directly in front of the weigher, makes the reading difficult with the ordinary window beam. In this the top of each beam is flat, and has the figures stamped clearly upon that part, instead of upon the side, as is ordinarily done, in which case the light from without the window is made the best use of in illuminating the figures, while they are seen from about the same angle by the observer. There are several other excellent points in this beam, such as the near mode of supporting the beams; the top or cap, for example, to which the beam is usually hung, is done away with, leaving a clear and open space through which the wagon or object on the scale may be viewed unobstructedly. It can be placed directly upon the window-sill, if necessary. It also makes a very light and desirable arrangement for dormant scales for use in warehouses, etc. At the butt end of the beam will be seen a new ball for adjusting or balancing the scale, which is quite an important feature. The ordinary ball is often turned by the vibration and shaking of the scale during weighing, thus giving false results; in this arrangement the "ball" is given a heart shape, and can not turn, being held in position and propelled back and forth by the hand only, by means of the screw at the end of the beam. This arrangement was awarded a medal by the Franklin Institute last year. Among their novelties, although not to be classed with either weighing or testing machines, is a very neat little arrangement for making hay or straw rope, shown in Fig. 6. The hay or straw is fed in at one end of the machine, and by a motion of the pedal, seen on the right, the reel is retarded at the will of the operator. This little machine saves considerable labor, beside making the straw or hay bands much better than can be done by hand.

The exhibit of this concern is always attended by a number of interested visitors, particularly when the testing of materials is in process, and that is every day. They quite recently made an exceedingly interesting test of the leather and rubber belting under direction of the judges, which was witnessed by a large crowd of both interested and disinterested parties. In point of importance, as well as for the many novelties exhibited in their particular line, these exhibitors compensate one well for the time spent in examination of their goods; and they are among the many at this exhibition who will be quoted abroad, as doing great credit to American manufactures. J. T. H.

THE NORWALK STEAM-ENGINE.

WE present in our engravings the Norwalk steam-engine. The girder frame is bolted to the cylinder head at one end, and the pillow-block at the other end. The crosshead is provided with jibs adjustable by set-screws and check-nuts. It is fitted with the Wheeler balanced piston-valve, which has double rings, having small holes through to admit steam inside the rings, and thus to overcome the difficulty and leakage arising from the steam pressing the rings in, while they are passing the cylinder steam ports. This valve can be removed at any time without removing any of the connections. The diameter of the engine piston is 12 inches, and its stroke is 24 inches. The fly-wheel is 7 feet in diameter, with a 14 face, and weighs 7000 lbs. The piston speed is 280 feet per minute, the engine making 70 revolutions per minute. The design is simple in construction, and the proportions are sufficient to make the working parts durable.





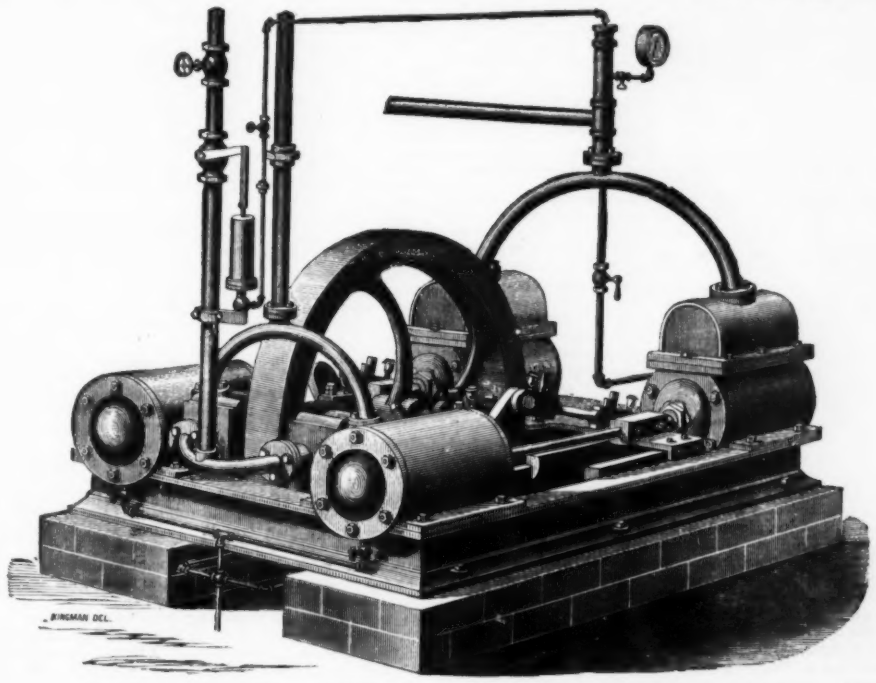
THE NORWALK STEAM-ENGINE.

PRINTING PRESSES AT THE EXHIBITION.

THE new newspaper fast printing press of R. Hoe & Co., New-York, was lately tried at the Exhibition and attracted much interest. The machine may be described as consisting of pairs of cylinders set in a massive framework. The first pair, over which hangs the roll of paper, consists of one type and one impression cylinder, and by it the first side of the paper is printed. The second pair, printing the second side, consists likewise of one type and one impression cylinder, but the latter is below the former and is of much greater size, so that the "set off" from the fresh ink shall not fall continuously on the same surface of blanket. The third pair of cylinders cuts off the sheet, and the fourth (in which, however, one cylinder is replaced by a brace of rollers) gives the first fold and shoots the doubled sheet into the circular cutter, which slits it into two papers, sending them on to be folded again separately and delivered in their respective places in piles at the sides of the press. The type cylinders carry not type but stereotype plates, cast to the proper curve, and the ink is conveyed to their swift-moving surfaces by a series of "composition" rollers from the fountains placed near them. The whole machine stands so low on the floor that every part is under the pressman's eye. It is a double machine, printing two complete papers at once, side by side, and delivers the sheets not flat, but folded, at a speed of twenty-eight thousand eight hundred papers per hour. Yet, with the regularity of a clock, and with little more noise, this torrent of papers was, during the whole hour of trial, received, accurately folded and neatly piled. The press stopped twice in the hour on account of broken paper, and once to take out a melted roller, but not once did the folding machine fail to perform its part.

THE NIAGARA DUPLEX AIR-PUMP.

OUR engraving represents the above-named pump, which is kept in continuous operation in Brewers' Hall at the Centennial.



THE INTERNATIONAL EXHIBITION OF 1876.—THE NIAGARA AIR-PUMP.

The general arrangement of the parts is that of two distinct and complete pumps held upon one frame, and connected together so far as the frame, and the supply and discharge pipes at the air as well as at the steam end, are concerned. About midway upon the frame is an intermediate shaft with cranks at each end, one being at a right angle to the other, and both being connected to the crossheads by ordinary connecting-rods. Upon the intermediate shaft are the fly-wheel, and two eccentrics which operate the slide-valves of the steam-cylinders. The object of this duplex arrangement is to give to the pump an equal capacity to start in any position of the crank, that is to say at any part of the stroke, avoiding any dead centre. The steam and air cylinders are 6 inches in diameter, the length of the stroke being 8 inches. The piston-rods are solid, and of either gun metal or wrought iron, as preferred; they are secured to the piston heads by a taper as well as by a nut and check-nut at each end. The steam valve-spindle passes clear through the valve, and is secured thereto by nuts and check-nuts. The steam piston-heads have each two ordinary steam piston packing rings, which are set out to fit the cylinder bore by a broad internal ring, eccentric in thickness, and being thinnest at the split. The air-pistons are fitted with Tuck's rubber packing, the clearance allowed at each end being $\frac{1}{16}$ inch. The valves for the steam cylinders are ordinary steam slide-valves, without lap on either the steam or exhaust side more than sufficient to just isolate the steam from the exhaust port. The sizes of the cylinder ports are: steam ports $\frac{1}{2}$ inch, exhaust port $1\frac{1}{2}$ inch, in width. The air-valves are on the griddle principle, being formed of pieces of thick rubber, with guards behind them. The discharge valves are removable when necessary through hand holes, provided in the air-chests, which may be opened by the removal of three bolts. The inlet air-valves are bolted to the outside air-cylinder heads, and are removable with those heads. The bed at the air pump end is hollow, providing a common air supply chest, whence both pumps draw their supply. The supply or suction-pipe is intended to be carried to any cool part of the building, or what is better, to the ice-house. Lubrication to the air-pistons is provided by a drip-pipe, supplying drops of water into the suction air-pipe. The chambers at the top of each air-cylinder are connected by a branch pipe, from the top of which starts the general delivery pipe, which may have from it as many branch pipes as it is intended to operate casks, which may be from one to six at option.

Steam is supplied to the steam-chests through a branch pipe entering at the top of each steam-chest the exhaust pipe being a similar branch pipe connected at the outside ends of the steam-chests. The connecting-rods are provided at each end with straps, keys, and jibs of the usual form. The eccentric-rods are secured to the straps by a screw and check-nut, and to the valve-spindles by a strap, jib, and key. The crossheads are provided with brass jibs, adjustable by set-screws and check-nuts. The pressure of air supplied by the pumps is kept at a constant and even pressure by means of the governor, which is a special feature of these pumps. Its construction is as follows: In a small and long cylinder is fitted, an easy-working but air-tight fit, a piston, attached to a rod provided with a collar to sustain a weight, and attached at the other end to a balanced throttle-valve, provided in the engine steam-pipe. The weight referred to is turned cylindrical, and with a flange at the bottom, so that by slipping rings on it it can be increased: the governor stands upright, and with the weight, of course, above the piston, so that by placing the delivery pipe from the air-pumps in connection with the under side of the small governor piston, an excess of air pressure forces that piston up its cylinder or barrel, and the rod closes the throttle-valve in the steam pipe. This is a simple and excellent arrangement, because the instant the air pressure exceeds that to which the governor is set, the throttle-valve is commensurately closed, nor does any amount of movement of the governor piston affect its adjustment; had a valve and lever arrangement been used, the increase of area due to opening the valve lever, together with the variation in the leverage due to the movement, would have caused an appreciable difference, between which the pressure at the valve would open and close. As it is, however, $\frac{1}{4}$ lb. per square inch is sufficient to overcome the friction due to the working of the governor, and the pressure in the cask can be kept within that range, no matter how much the pressure in the steam-boiler may vary, so long as it is sufficient to run the pumps. The pumps may be therefore left without an attendant; and supposing there are four casks being racked, it is of no consequence if all four are being racked at once, or if one, two, or three be shut off, the pressure of those in actual operation will remain at all times the same, the consumption of steam being in any event commensurate to the actual work performed, because the regulating is done in the steam-pipe. If racking operations are entirely ceased all at one time, the engine stops itself; and so soon as racking recommences, the pumps start themselves, because of the cranks being at right angles one to the other, and hence the necessity and advantage of making the pumps duplex. J. R.

AMERICAN SILVERWARE AT THE CENTENNIAL.

THE supremacy of the American plated goods over those of foreign countries is just as undisputed as that of the more costly silver articles. People of moderate means are now able to possess articles of real beauty that would have been wholly beyond their reach twenty years ago. An exceedingly handsome display of plated ware is made by the Meriden Britannia Company in the central aisle of the Main Building. Their show-case is generally pronounced the finest in the fair, and is worth seeing for itself, irrespective of the brilliant things it contains. It is in the form of an elegant pavilion of ebony, gilding, glass and Tennessee marble, with a roof

of blue and a cupola, upon which is a gold ball supporting an eagle. Within this little palace is the office of the representative of the company, who shows visitors a model of the apparatus used for plating with an ingenious attachment regulating to a grain the amount of silver that is to go on the articles immersed in the galvanic bath, and also the process of giving extra thickness of plate to the parts of spoons and forks most exposed to wear—a specialty of this establishment. Only a few of the many beautiful articles that crowd the cases forming the walls of the pavilion can be mentioned here. A yacht of metal so fine and white that it is frequently mistaken for glass is admirably modelled. The Indian epergne and the Neptune epergne are excellent specimens of elaborate work of a high order of artistic merit. A centre piece of oxidized silver representing a buffalo hunt, a prize cup with exact models of farmers' hunting dogs, and two large wall-plaques, with fairies sitting upon vines, are especially noticeable.—*N. Y. Tribune.*

AMERICAN IRON BRIDGES.*

By T. C. CLARKE, Member of the Institution of Civil Engineers, and of the American Society of Civil Engineers, etc.

SOME philosopher has said that *results* come from internal impulses modified by external conditions. Applying this to European bridges, we find that the internal impulse is *first* to make as strong and as safe and as durable a structure as possible, and that the question of cost holds a secondary place. The external conditions are, plenty of time and rivers of comparatively uniform regimen, so that there is but little danger of scaffoldings being washed out by floods during erection.

Hence we find, consecutively—stone arches; cast-iron arches; plate girders; and, finally, lattice girders of plates and angles riveted together, copying the proportions already established for plate girders.

In this country, on the other hand, the internal impulse is to build the bridge (and in fact every thing else) in as short a time as possible, and for the least possible sum. Hence our railway bridges were originally made of the most abundant and cheapest material—wood; and so designed as to be put together with the utmost rapidity, inasmuch as our rivers are subject to sudden and heavy freshets, and it never is safe to trust the bridge long supported by staging, which may be washed out in a night. Hence, when we began to build our iron bridges, we copied the proportions already established as most economical in wooden trusses, and instead of riveting the several parts together on the scaffolds, we adopted the use of tenons and sliding-joints for the compressive members, and of pins and eye bars for those in tension, which enables us to erect our bridges, without fitting, very rapidly.

Having begun in this path, we have seen no reason to depart from it. We find that great economy of material (which simply means little dead weight) is got by concentrating the iron along the lines of strain, by making long panels (which means few parts), and by proportioning our girders of a depth of never less and often more than one eighth of their span. The form of truss now almost universally adopted, and which (by a process of natural selection) has almost driven out of use the Bollman, Fink, and triangular girders, is the quadrangular girder with vertical posts, and main tie bars inclined at an angle as nearly 45° as possible. This has the merit of subjecting the iron to strains in one direction only—either tension or compression, and if we agree with Herr Wöhler that iron strained both ways is as highly strained as if the tension and compression were added together—this is a point of no small importance. We prefer to hang our cross floor beams from the pin, because then the load is transferred directly by the diagonal tie bars, without any bending moment.

Our peculiar web system allows us to give great height to our trusses, sufficient to enable us to put in vertical transverse bracing high enough to clear the smoke-stacks of the locomotives, which, we think, adds much to the lateral stiffness of our bridges.

The usual practice of American engineers is to provide, in addition to the weight of the structure itself, for a general rolling load of 4000 lbs. per foot for spans of 50 feet and below; 50 to 100, 3000 lbs.; 100 to 150, 2750 lbs.; 150 to 250, 2500 lbs.; 250 to 300, 2250 lbs.; above 300, 2000 lbs. In addition to this, the floor and panel system is strengthened to provide for a load arising from the concentrated weight of the engine of 3500 and sometimes 4000 lbs. per foot lineal. Strains in tension are taken at 10,000 lbs. per square inch, and in compressions 8000 to 10,000 for chords of 10 to 14 diameters, and 4000 to 6000 for posts of 20 to 30 diameters.

So much for the design of our bridges. When we come to examine the methods of construction we shall see that the marked feature is the use of special machine tools, by which the sizes and lengths of all the parts are fitted with the utmost exactness at the place of manufacture. The ends of the upper chords and of the columns are faced in lathes; and the lower chord bars and diagonal tie bars are drilled with a pair of drills set on a wrought-iron bed, so as to give absolute accuracy of length. The pins are turned and fill the holes so well that 1-100 of an inch is the limit of end allowed.

Now the point to which I particularly wish to call your attention is that when once the machinery is provided this accuracy of workmanship costs nothing. Hence there can be no disposition to slight work and make imperfect joints and bearings. The process of manufacture is the best inspection possible. The bridge is calculated to come to a certain camber, and if it does not come to that camber, or if any of the eye bars are loose, something must be wrong.

Now, every one who has ever built riveted lattice bridges knows that unless iron templates are used and the greatest possible care taken in laying out the work that the rivet holes will not come opposite to each other, and either driffling or rimming must be allowed. Exactness of workmanship *can* be attained, but it costs the maker a great deal more money than rough fitting, while in the machine-made bridges there is no inducement to do poor work.

As to the actual economy of material, perhaps the best illustration that I can give you is to quote the weights of the 200 feet spans over the Minamadic River, on the Intercolonial Railway of Canada, a picture of which hangs on the west gallery of the Main Building. Tenders were received for these bridges from various European, English, and American bridge-builders. There were 17 spans of uniform length, and these were all designed on the same specification—namely, to carry a general moving load of 2800 lbs. per lineal foot, and a load on floor system of 3600 lbs. per foot; strains in tensions, 10,000 lbs. per square inch; in compression, on chords 7500 to 8000 lbs. per square inch, or posts 4000 to 6000 lbs.

The different designs may be divided for purposes of comparison into four classes:

1. Riveted lattice girders, short panels, 6 to 8 feet long; low trusses, 16 to 18 feet high; weights, 244½, 221, 206½, 202 tons.

2. Riveted lattice girders, panels, 9 to 10½ feet long; trusses, 20 feet high; weights, 141, 140, 137, 144½ tons.

3. Pin-connected trusses, panels, 9 to 11 feet; trusses, 20 to 22 feet; weights, 128½, 126½, 122 tons.

4. Pin-connected trusses, panels 12 to 14 feet long; trusses, 25 to 28 feet high; weights, 111, 109½, 102 tons.

It will be observed that the saving of dead weight is due more to the design than to the difference between riveted and pin connections. We may say roughly that the difference due to this cause alone, is nothing for spans of under 100 feet; from 100 to 200, 5 to 20 per cent. Above 200, the increase is rapid in favor of pin connections.

When we come to examine the question of rapidity of erection, the pin connections have a great advantage. They can not only be built much quicker, but they require no skilled labor; any ordinarily intelligent laborers can erect them, under a good foreman. Those of my hearers who have had the opening of their lines delayed by a strike of the riveters can appreciate this point.

Spans up to 150 feet can be erected by a gang of 20 men, in a single day, if necessary; a 200-feet span, two to three days; a 250, three to four, etc.

As we put a less quantity of iron in our bridges, we are able to use a better quality. In fact, it is difficult to make the eye-bars, forged by hydraulic pressure, except out of a good quality of iron. All the iron used for the tensile members of the bridge at Phœnixville is made as follows:

They take a high quality of gray forge pig-iron, and work it in a furnace by the process technically known as "boiling," the boiling furnace being "fettled" with ore. This pig-iron when "brought to nature" is balled up in the furnace in the usual way, squeezed in a Burden squeezer, and then rolled into a flat bar, technically known as "muck bar," or No. 1 bar.

From each heat so made one bar is taken and bent to an angle of 45° cold; if it stands without any signs of fracture the heat is passed as good; if not, it is rejected.

The iron that has passed this test is piled, charged in a heating furnace, heated and rolled into flat bars. This is called No. 2 bar, and is sold as "Phœnix Best." The iron so rolled is again cut, piled, and rolled into the finished bar, and is called No. 3 bar and is the iron sold by the Phœnix Iron Company as "Phœnix Best Best." A bar of this iron, 2⅜ inches diameter, has been bent cold so that the sides came in close contact without showing the least signs of fracture.

It should be borne in mind that the object of re-working iron is to refine it by getting rid of the surplus cinder and scoria, making the iron firm in texture and of a more uniform quality. This uniformity of quality results from the fact that the pile from which a bar of No. 2 is made consists of fourteen No. 1 bars, and the pile of No. 3 of eight No. 2, so that if by chance an inferior muck-bar had been used, it would form but 1-112 part of the No. 3, or "Best Best" bar.

All iron improves up to the third working, but if the quality of the pig is not suitable no amount of working will make the product good iron; hence the necessity for tests as to toughness and stretching.

The specification is as follows:

A round bar, 1½ inches diameter, by 12 inches long; ultimate strength, 55,000 to 60,000 lbs. per square inch; no permanent set under 25,000 to 30,000; reduction of area at breaking-point, 25 per cent; elongation, 15 per cent; cold bend from 90° to 180°; but it always does much better than this, as in the instance of the 2⅜ bar quoted above.

The rule adopted for pins and eyes is to make the pin diameter about four-fifths of the depth of flat bar, or one and one third the diameter of round or square bar. The eye has from 50 to 66 per cent of excess of area of metal over body of bar, and the thickness of flat bars is never made less than one quarter of the depth.

Some fear has been expressed by those more familiar with riveted than with pin construction, lest the pins might become worn away by use. There is not the slightest danger, provided the pressure of bearing surfaces does not exceed, say 10,000 lbs. per square inch, with the accurate workmanship of our pins turned from cold rolled shafting, and eye bars drilled to a 1-100 of an inch. Wear is simply impossible. But even with very rough workmanship, where the above limit of pressure in not exceeded, the wear is but slight.

One more point, and I have done. In Europe I believe that the practice is to receive tenders by the pound upon detailed drawings.

In the United States the engineer makes a general specification, giving the lengths of spans, width, angle of skew if any, the loads the bridge must be designed to carry, and the limit of allowed strains, leaving all details of construction and arrangement of depth, length of panels, etc., to be determined by those competing.

Different engineers, either connected with bridge establishments, or acting independently, but all following that branch as a specialty, make plans in accordance with the specifications, and tender so much per foot or per span, keeping the weights to themselves. These methods have their advantages and corresponding disadvantages.

The European method, while securing plenty of iron, and safety in construction, has overloaded its bridges with dead weight, and made very long spans unattainable except at great cost, from there being no competition in design.

The American method has up to this time secured both a safe and an economical use of material, and good quality of iron and workmanship. This has been due directly to competition in design.

But, as prices fall, the tendency is to economize material too much, particularly in short spans, which ought relatively to be stronger than long spans, which are strained chiefly by dead loads. The next step will be to use an inferior quality of iron, unless this is prevented by rigid inspection, or, as in the buying of locomotives, purchasers trust in a great measure to the reputation of the large establishments, which is too valuable to be sacrificed for a few tons of iron.

Where this guarantee is not attended to, as in the case of county-road bridges, which are almost always let to the lowest bidder, entirely irrespective of skill or reputation, the most disastrous results follow. If a county-road bridge will stand up until it is paid for, it is considered a good bridge. It is said that the elephants who travel with menageries, when they encounter an iron road-bridge, can not be prevailed upon to even try to cross it. A wooden bridge they will condescend to examine, and if it seems firm, they will sometimes go over it. But when they see an iron bridge, they take for the river, and argument is in vain.

* Read at a Conversazione of the American Institute of Mining Engineers, 1100 Girard street, Philadelphia, June 8th, 1876.

THERE was coined in the San Francisco mint during the year ending June 30, $35,989,500, of which $27,033,000 was in gold coin. This is the largest annual coinage of any mint in the United States.

FRENCH ACADEMY OF SCIENCES.

JUNE.

On the Influence of Temperature on Magnetization. By M. J. M. Gaugain.—When a bar submitted to the action of a determinate magnetizing force is carried successively from the temperature t to a more elevated temperature T, then returned to the temperature t, heated anew to T, and so on, both values of magnetization which correspond respectively to the two temperatures t and T, at first increase gradually, but finish by becoming sensibly invariable when the heating and cooling are sufficiently repeated. The bar undergoes, therefore, two kinds of modification: one permanent, which results in augmenting the magnetization corresponding to any given temperature; the other temporary, which has the effect of diminishing or augmenting the magnetization according as the temperature is elevated or lowered. The author has attempted to determine the extent of these modifications in the Sheffield and Allavard steels. The difference between the two magnetizations obtained after four heatings has been in several experiments 27 per cent of the magnetization corresponding to the temperature of 68° Fah. for Sheffield steel, and 11.8 per cent for Allavard steels. According to the theories advanced hitherto by M. Gaugain, the permanent modification represents a true increase of magnetization.

On a Differential Electro-Actinometer. By M. N. Egoroff.—This note relates to an apparatus designed for determining more exactly the coëfficients of absorption of the ultra-violet rays through different media. The Becquerel actinometers are so disposed that the current of one neutralizes that of the other. In the circuit a galvanometer of 30,000 turns, and very sensitive, is introduced. M. Egoroff's experiments appear to demonstrate that there is an exact proportionality between the intensity of the light and that of the current. The great sensibility and precision of the apparatus render it a very delicate photometer.

On a New Class of Coloring Matters. By M. C. Lauth.—The substances which have served to produce these new matters are the aromatic diamines obtained by reducing the nitrated derivative arising from the acetylic combination of organic bases. Thus, taking aniline as an example, acetanilide is first prepared, then nitracetanilide and nitraniline. Finally, the nitraniline is reduced either by iron and acetic acid or by tin and hydrochloric acid. In the first case, when the reaction is terminated it is necessary to add an excess of lime to the mixture and distill. There is thus obtained the β-phenylene-diamine, which a single rectification gives completely pure. In the second case a liquor is yielded whence the tin is eliminated by zinc, when it then may serve directly for the production of the new coloring matter. The principal color obtained is a new violet, giving very pure shades much bluer than those obtainable from the "Violets de Paris," and keeping their special tone under artificial light. Like the majority of similar substances when heated with aniline, it gives a blue insoluble in water and soluble in alcohol. Submitted to the action of aldehyde, iodide of methyl, etc., under ordinary conditions, it becomes transformed into blues more and more greenish. These are of great purity, and present the novel characteristic of being soluble in water and of fixing themselves as a dye by the simple immersion of the fibre in the bath.

On New Derivatives of Isoxylene. By M. Gundelach.—The derivatives are chloride of isotolyle, $C^9 H^9 Cl$, of which the density at 86° Fah. is 1.064, and isotoluic aldehyde, the density of which at 69° is 1.024.

On the Spirophorus—a Safety Apparatus for Reviving the Asphyxiated. By M. Orvillez.—This apparatus is composed of a cylinder of thin metal closed at one extremity. It is large enough to receive the body of the patient up to the neck, around which an air-tight cover fits. A powerful bellows containing about five gallons of air is connected to the case by a large tube. The bellows is operated by a lever, and its inflation withdraws the air from the case, while by compression the same air is forced in again. A pane of glass is inserted in the front part of the cylinder, and allows of the chest and abdomen of the patient being seen, while a movable rod sliding in a tube fixed above is placed so as to rest on the sternum. The artificial respiration produced by the bellows is said not to endanger the lungs, and to be very efficacious in reviving persons partially drowned or otherwise suffocated.

PHYSICAL SOCIETY.—LONDON, MAY 27.

Prof. GLADSTONE, Vice-President, in the chair.

SELECTIVE ABSORPTION.

MR. W. ACKROYD read a paper on "Selective Absorption." Two typical experiments were shown upon which a division of selective absorption may be based. In the first, light is transmitted through bichromate of potash at the normal temperature, and again at about 200° C., and the spectrum of the transmitted light is examined. The widening of the absorption bands, which takes place at the higher temperature, is traced to structural alterations. In the second experiment, light is sent through two thicknesses of the same colored solution, as, for example, sulphate of copper, and in the greater thickness the absorption-band has widened out, but this is plainly not owing to any structural alteration. That in the first experiment he proposes to term *structural*, and that in the second *transverse* absorption, and he considers that these two kinds have not hitherto been sufficiently distinguished. Certain color relations which exist among anhydrous binary compounds led the author to the conclusion that the width of a structural absorption-band bears a direct relation to interatomic distance. The necessity for separating high-temperature spectra from low was shown, and the bearing of the subject on the study of organic coloring-matters briefly alluded to.

REMARKABLE ATMOSPHERIC PHENOMENA IN CEYLON.

The Secretary then read a communication from the Rev. R. Abbay on certain "Remarkable Atmospheric Phenomena in Ceylon." The most striking of these is witnessed from the summit of Adam's Peak, which is a mountain rising extremely abruptly from the low country to an elevation of 7200 feet above the sea. The phenomenon referred to is seen at sunrise, and consists, *apparently*, of an elongated shadow of the mountain projecting westward to a distance of about seventy miles. As the sun rises higher it rapidly approaches the mountain, and appears at the same time to rise before the observer in the form of a gigantic pyramid of shadow. Distant objects may be seen through it, so that it is not really a shadow on the land, but a veil of darkness between the peak and the low country. It continues to rapidly approach and rise until it seems to fall back upon the observer like a ladder which has been reared beyond the vertical, and the next instant it is gone. Mr. Abbay suggests the following explana-

tion of the phenomenon: The average temperature at night in the low country during the dry season is between 70° and 80° F., and that at the summit of the peak is 30° or 40° F.; consequently the low strata of air are much the less dense, and an almost horizontal ray of light passing over the summit must be refracted upwards and suffer total internal reflexion, as in ordinary mirage. On this supposition the veil must become more and more vertical as the rays fall less horizontally, and this will continue until they reach the critical angle, when total internal reflexion ceases and it suddenly disappears. Its apparent tilting over on the spectator is probably an illusion produced by the rapid approach and the rising of the dark veil, without any gradual disappearance which can be watched and estimated. It will be evident that the illumination of the innumerable particles floating in the atmosphere causes the aërial shadow to be visible by contrast. Another interesting phenomenon visible in the mountain districts admits of an equally simple explanation. At times broad beams, apparently of bluish light, may be seen extending from the zenith downwards, converging as they approach the horizon. The spaces between them have the ordinary illumination of the rest of the sky. If we suppose, as is frequently the case, that the lower strata of air are *colder* than the upper, the reflexion spoken of in the case of Adam's Peak will be downwards instead of upwards. If several isolated masses of clouds partially obscure the sun, we may have several corresponding inverted veils of darkness like blue rays in the sky, all apparently converging towards the same point below the horizon. This latter phenomenon is called by the natives "Buddha's Rays."

PERIODIC WAVES.

Prof. Forel, of Morges, Switzerland, then gave, in French, an account of some interesting experiments which he has recently made on the periodic waves which take place on the Swiss lakes and are there called "Seiches." It was long since observed that the waters of most of these lakes are subject to a more or less regular rise and fall, which at times have been found to be as much as one or two metres. M. Forel has studied this phenomenon in nine different lakes, and finds that it varies with the length and depth of the lake, and that the waves are in every way analogous to those already studied by Prof. Guthrie in artificial troughs, and follow the laws which he has deduced from his experiments. Most of the experiments in Switzerland were made on the Lake of Geneva, but that of Neuchatel was found to be best fitted for the study of the subject, possessing, as it does, an extremely regular geometric form. The apparatus he employed was very sensitive to the motion of the water, being capable of registering the waves caused by a steam-boat half an hour after it had passed, and five minutes before its arrival; and was so constructed as to eliminate the effect of common waves, and to register the motion, side by side, with a record of the state of the barometer, on paper kept in continuous motion. While he found the duration of waves to be ten minutes at Morges it was seventy minutes at Geneva, and this is explained by the narrowness of the neck of the lake at the latter place. This period he proved to be independent of the amplitude, and to be least in the shortest lakes. For shallow lakes the period is lengthened; and his observations show that the period is a function of the length and depth, and that longitudinal and transverse waves may co-exist, just as Prof. Guthrie has shown to be the case in troughs.—*Academy.*

THE IMPORTANCE OF A KNOWLEDGE OF THE LAWS OF HEALTH.

By THOMAS BOND, F.R.C.S., M.B., and B. S. Lond.,
Assistant Surgeon to Westminster Hospital,
and Lecturer on Medical Jurisprudence.

1. ON an average, one half of the number of out-patients treated by a hospital surgeon suffer from diseases due primarily to a want of knowledge of the laws of health and cleanliness. The ignorance of hygienic laws, which affects so disastrously the health of the rich as well as the poor, exists chiefly in regard to dress, ablution, and ventilation. This statement may, at first, appear startling, but an enumeration of the diseases that can be constantly traced to the above causes will show upon how sound a basis the statement rests. The following are examples: Varicose ulcers from dress; skin diseases from want of cleanliness; chest diseases and fevers from defective ventilation. The vast number of ulcerated legs treated in the out-patient department of hospitals, in workhouse infirmaries, and in private practice, arise from varicose veins. Now, a varicose ulcer is caused by a distended condition of the veins of the leg, which have to sustain the pressure of the blood caused by gravitation. In varicose veins, the valves which help to support the column of blood are, to a great extent, destroyed, through the veins having been distended by mechanical obstruction to the free return of the blood from the extremities, thereby distending the lower veins and separating the edges of the valves. Thus, the weight of an uninterrupted column has to be borne by the veins. This, of course, causes further distention, giving rise to congestion of the capillaries of the skin, and causing swelling, eczema, and ultimately ulceration. This is the varicose ulcer so common in the laboring classes. It is always difficult to heal, and often impossible, except by prolonged rest in bed. Hence it is the dread of the surgeon, and the cause of misery to thousands. Varicose ulcers are seldom admitted into general hospitals, so that hundreds of poor families are driven to the workhouse, and such cases form a majority in the workhouse infirmary. The most frequent and flagrant cause of obstruction is the ordinary elastic garter. Children should never wear them at all, as the stockings can be perfectly well kept up by attachment of elastic straps to the waistband. If garters are worn, it is important to know how to apply them with the least risk of harm. At the bend of the knee the superficial veins of the leg unite, and go deeply into the under part of the thigh beneath the ham-string tendons. Thus a ligature below the knee obstructs all the superficial veins, but if the constriction is above, the ham-string tendons keep the pressure off the veins which return the blood from the legs; unfortunately most people, in ignorance of the above facts, apply the garter below the knee. Again, in nine out of ten laboring men, we find a piece of cord or a buckled strap tightly applied below the knee, for what reason I could never learn. Elastic bands are the most injurious. They follow the movements of the muscles, and never relax their pressure on the veins. Non-elastic bands during muscular exertion become considerably relaxed at intervals, and allow a freer circulation of the blood.

2. The habit of tight lacing again predisposes to varicose veins, in consequence of the abdominal viscera being pushed downwards into the pelvis, causing undue pressure on the veins of the lower extremities when they enter the pelvis. Physicians also have reported numerous cases of heart and lung disease caused by this pernicious habit.

3. The use of dress is often misunderstood; most persons evidently study and practise it with regard to appearance, or only to keep out wet and cold. The hygienic use of clothes, however, is not so much to keep cold out as to keep heat in. The mistake is often made, of taking great care to put on extra wraps and coats when preparing for out-door exercise. This is not at all necessary in robust persons. Sufficient heat to prevent all risk of chill is generated in the body by exercise. The care should be taken to retain sufficient clothing after exercise, and when at rest, to prevent the heat passing out of the body. Indeed, persons very often catch chills from throwing off extra clothing after exercise, or from sitting about in garments, the material of which is not adapted to prevent the radiation of heat from the body. Linen and cotton underclothing, when moistened by perspiration, parts with heat very rapidly, whereas flannel and silk, being non-conductors, prevent the rapid loss of heat.

4. The most recent offence against the laws of health is the habit of wearing false hair. The perspiration of the scalp is prevented by the thick covering from evaporating, thereby causing a sodden and weakened condition of the skin which predisposes to baldness and other diseases of the scalp. Again it produces headache and confusion of the intellectual faculties. We all know what a relief it is during hard mental work, simply to raise one's hair by running the fingers through it. I should think literary ladies either do not wear false hair or take it off when at work.

BATHING.

5. Ablution is another subject of paramount importance to health. Mr. Urquhart, the introducer of the Turkish bath into this country, is one of the benefactors of the age, and it is to be hoped some day there will be a bath in every town and village in England. Doctors are very much to be blamed for allowing themselves to be prejudiced against it. The usual opinion given by medical men to their patients is that it is debilitating, and only to be borne by the robust. The reverse is really the case; it is stimulating and strengthening, it is a preventive as well as a curative in disease. The effect of the Turkish bath on the skin is to cause an active condition of its functions of elimination, by removing the hardened epithelial scales, by removing the fat from the pores, and by causing the sweat glands to maintain the activity of their functions, giving a general stimulus to the vital power of the skin. Again, it keeps the body in a state of perfect cleanliness, which is so essential to robust health; but these are not its only virtues: it promotes purity of mind and morals. The man who is accustomed to be physically clean, shrinks instinctively from all contact with uncleanliness.

6. There are, however, certain precautions to be observed in the use of baths. Persons who are apoplectic, or suffering from fatty degeneration of heart, should not venture to disturb the circulation by the excitement of baths. The first effect of Turkish baths is to stimulate the circulation, the second to cause active congestion of the skin, the third to produce profuse perspiration, the fourth to keep down the temperature of the body by rapid evaporation. On leaving the Turkish bath the body should be douched with cold water; the capillaries are thus emptied of their blood by contraction, but immediately after the stimulation causes them to resume a state of activity, and produces vigorous circulation through the skin.

7. In taking a cold bath in the morning, the same conditions should be present. The surface of the body should be warm and moist; therefore, the bath should be taken immediately on rising from the bed, and before the surface of the body has had time to cool or the capillaries to contract. The shock of the cold water should cause them suddenly to contract, then quick reaction will take place in the same way as after a Turkish bath. Unless this reaction occurs after the bath, there is great danger of getting a chill; at any rate, the full benefit of the bath is not obtained. Persons with weak circulation, who can not take an ordinary morning bath, often derive great benefit from the Turkish bath. It opens the pores and improves the circulation of the skin, so that the shock of cold water can afterwards be borne. The same persons can generally bear a cold bath if they get for a few minutes into a warm bath first, and then immediately plunge into cold water. By these means an active reaction is brought about. Warm baths should, in my opinion, never be taken on rising except under the above conditions, but warm baths at night are often desirable. They should be taken just before going to bed, when they have the effect of relaxing the muscular system and of promoting sleep by soothing the activity of the brain by the withdrawal of blood from it. I do not think warm baths at night are weakening, as the depression of vital energy which may occur is recovered during sleep. In river and sea bathing, persons should be careful not to remain in the water too long, nor should they exert themselves sufficiently to cause exhaustion, as the power of reaction is much impaired thereby; neither should persons get into cold water when cooling. The old-fashioned idea that persons should wait to cool before plunging into the water is a fallacy. There is no danger in plunging into the coldest water in a state of profuse perspiration if the heart and arteries are in a healthy state. Of course it would be unwise to do so immediately after a full meal, as the action of the heart might be impeded by the distended stomach.

CHAMBER VENTILATION.

8. Many persons complain of always getting up tired in the morning. This is very often due to defective ventilation of the bedroom, or from using an undue amount of bedclothes and bedding. Feather beds are too soft and yielding, and partially envelop the sleeper, thus producing profuse perspirations. The habit of lying too much under blankets is also very pernicious, by reason of the carbonic acid exhaled by the sleeper being respired. Again, it is a common error to suppose, that by simply opening a window a little at the top a room can be ventilated; people forget that for proper ventilation there must be an inlet and an outlet for the air. In bedrooms there is often neither, and if there is a fire-place it is generally closed up. Again it is a mistake to suppose that foul air goes to the top of a room. Certainly the heated air goes to the top, but the chief impurity, the carbonic acid, falls to the bottom. There is nothing so efficacious in removing the lower strata of air as the ordinary open fire-place, especially if there is a fire burning. The usual defect in ventilation is the want of a proper inlet for the air. If the window be open, the cold air, being heavier, pours down into the room, causing draughts; if the door be open, or ajar, the same thing occurs. The perfection of ventilation may be obtained in any room with a fire-place by simply providing proper inlets for the air, and nothing answers so well for the purpose as the upright tubes invented by Mr. Tobin. By this means the heavier external atmosphere ascends vertically through the tubes like the jet of a fountain, displacing the warmer and lighter atmosphere of the room, which finds its exit up the chimney. The tubes should communicate with the outer air on a level with the floor, and should be carried vertically upwards in the room for about four or five feet. A constant supply of fresh air is thus insured without the slightest liability to draught, as the current goes directly upwards till it strikes the ceiling. It is then diffused downwards, mixed with the heated air of the ceiling. The same principle can be carried out in any room with a sash window, by cutting out two or three holes an inch wide and three inches long in the wood-work of the upper sash where it joins the lower one. The columns of air ascend directly upwards, just inside the window, and mix with the heated air in the upper part of the room. If this system were universally carried out, we should hear less of rheumatism and chills caught by sitting in draughts.

9. Persons should cultivate the faculty of detecting sewer-gas in houses. Typhoid fever is often caused by the escape of this gas into the house through defect of the traps and drains. However bad the drains may be outside the house, there is little to fear, provided the gas can escape externally. The following two very simple precautions would naturally diminish the cases of typhoid fever: First, every main drain should have a ventilating pipe carried from it, directly outside house to the top of the highest chimney. Secondly, the soil-pipe inside the house should be carried up through the roof, and be open at the top.—*Journal of the Society of Arts.*

DWELLINGS FOR WORKMEN.

A VISIT was recently made by the Architectural Conference, London, to the Industrial Dwellings, near Bethnal Green Station, erected by the "Improved Industrial Dwellings Company," which has Sir S. Waterlow for its chairman. Here 15 blocks, of 10 tenements, each about 33 ft. frontage by 40 ft. deep, have been erected, two tenements being on each floor. The members inspected the blocks, which are of five stories in height, and have bay windows of three stories to each block. This gives a little diversity to the external elevations. The general arrangement elicited much attention from those present. There are three rooms to each tenement, and each dwelling has its own street or entrance-door. The front room is 13 ft. by 11 ft., behind which is a bedroom 14 ft. by 7 ft. In the rear lobby is a water-closet, a coal-bunker, and food-closet, and a scullery, with copper of cylindrical shape, lined with sheet-iron. The coal-bunker and water-closet are arranged together in the centre of each block, and are closed off from the scullery by a door. The entrances are also together in the centre with the staircase, each being 3 ft. wide, and these lead to lobbies which give access to the bedrooms and sculleries behind. A dust-shaft behind in the division wall between two dwellings delivers into an ash-pit in the basement, and its upper end opens above the roof for ventilation. The soil-pipes are ventilated by a continuation of the pipe by a tube about 10 ft. above roof-flat, with a roof-trap and grating around it, which takes the water from the flat. These flats are used for drying purposes. We find that there are 1638 dwellings occupied, and 574 are in course of erection, the total number being 2212. The rents average about two shillings a room. We may say, in reference to the materials and construction, there is little new or original; the floors are of ordinary construction, but the joists are notched on ⊥ iron bars, laid in the inner half brick. The material of the walls is brick, with artificial stone lintels and dressings, this composition being made of coke-breeze and cement in the proportion of six to one. The stairs and lobbies are of the same material, and are therefore fire-proof; the steps are cast solid in moulds, and the staircase landing and entrances in front form a continuous vertical opening, with spandrel girders of iron carrying the landings. The company are their own builders, and Mr. Ward Lee, of 33 Finsbury Circus, is the architect. Perhaps there is a little too much ornament attempted in the cast work, and hardly enough attention to new appliances in the shape of provision for washing and laundry purposes. The buildings are, however, of a very substantial character, and must be a great boon to the dense district of Bethnal Green.—*Building News.*

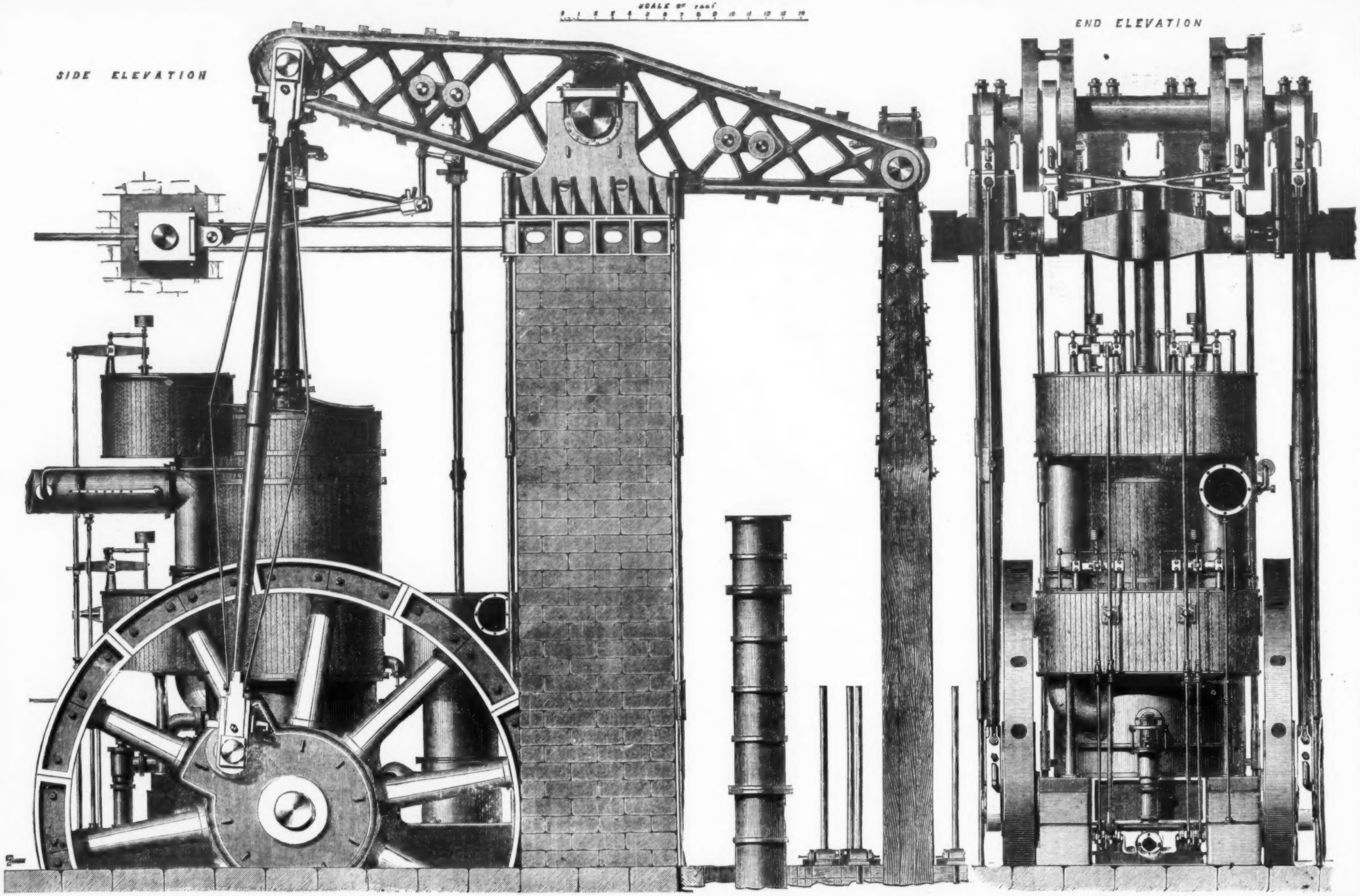
RECENT TRIALS OF A NEW 38-TON GUN IN ENGLAND.

THE *Standard* says: "Fifty rounds were fired in 1h. 40m. 10s., the average time per round being 1m. 59s. The velocity of the 800-pounder Palliser projectiles fired with these battering charges of 130 pounds of powder is such as would give them great power at the distances of the targets, being 1500 feet per second at the muzzle of the gun, 1369 feet at 1000 yards, and 1212 feet per second at the 2500 yards, so that we may reckon that a very substantial iron-clad would have had a good punching even at the range of the most distant of the targets.

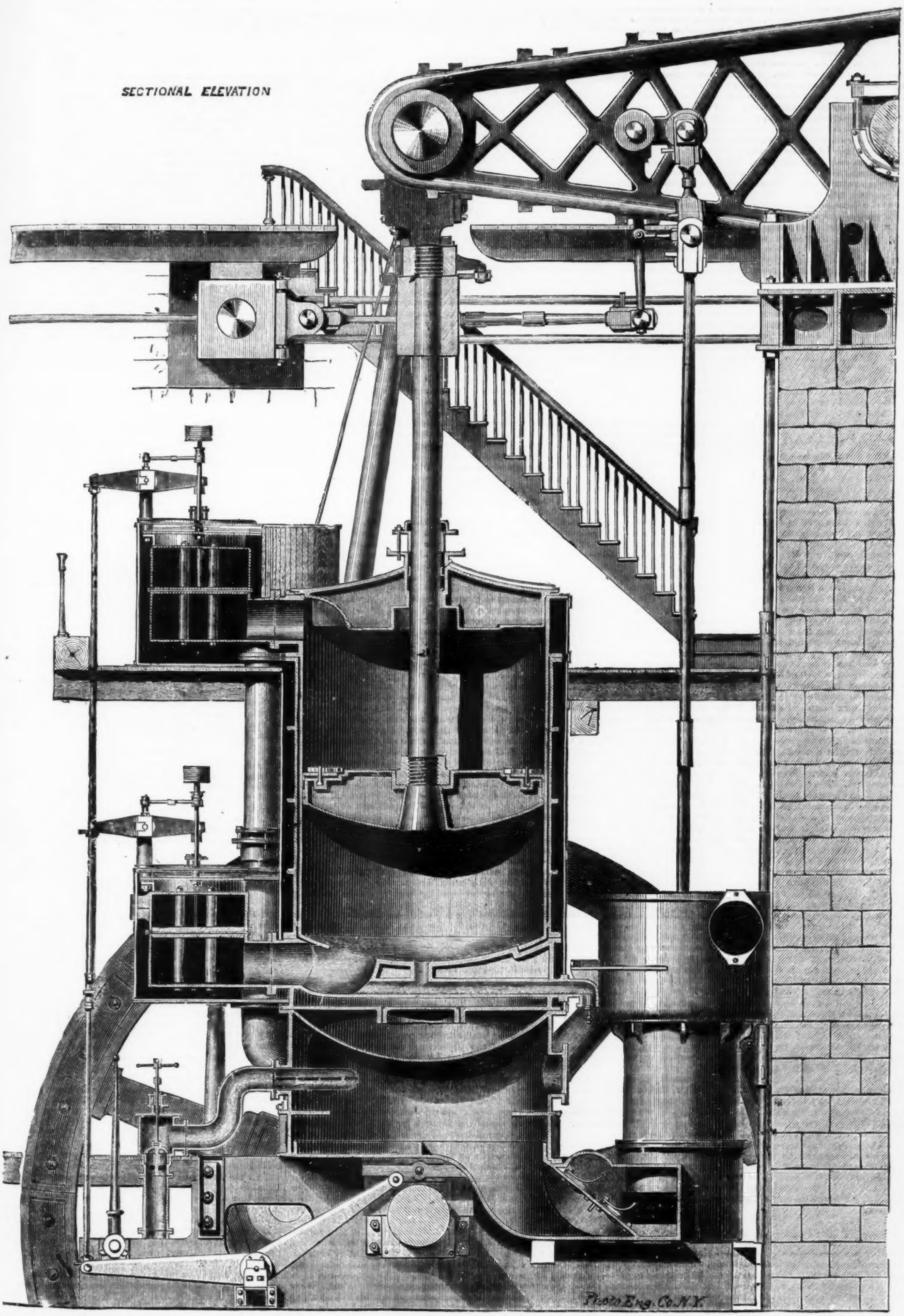
"Of the gun itself we may add the following details: Length over all, 18 feet 9½ inches; length of bore, 16 feet 6 inches; diameter of bore, 12½ inches; rifling, nine grooves on Woolwich system, commencing at 27½ inches from base of bore, the grooves being splayed at the muzzle of the gun for convenience of getting in the shot. The carriage on which the gun is mounted weighs 7 tons 15¼ cwt., and the platform 5 tons 19¼ cwt. Add to this the weight of the gun, and we have 53 tons, roughly, as the weight to be moved and shifted about by the seventeen men of the gun detachment at every round within the two minutes' speed attained. As to the accuracy of the shooting, we believe there is nothing on record equal to these two days' practice, and certainly none of the gun carriages and platforms of any of the previous heavy guns ever worked so smoothly, certainly, and exactly."

MINIATURE MAPS.

IT will be remembered that during the siege of Paris a good deal was done in the sending of photographically reduced despatches by balloons. The inventor of the method of reduction, M. Dagron, has lately applied it to the production of maps. In this way the whole official map of France is brought into form that can be easily carried in a pocket-book; and maps of all countries of Europe are arranged to be carried on a cartridge-belt along with the magnifying apparatus (*telémetre micrographique*), a joint invention of Dagron, Dallemagne, and Riboulet. The reduction of the maps can be on any required scale. The smaller this is the more convenient the magnification. The telemeter has the size and form of a stereoscopic apparatus. By means of it all the details of the original map are greatly enlarged, and can be easily studied. In darkness the light of a match or even the glowing of a cigar suffices to enable one to read off the map at once. The French anticipate these maps will prove very serviceable in case of war and also for educational purposes.



PUMPING-ENGINE OF THE LEHIGH ZINC COMPANY, PENNSYLVANIA.—(*See page* 504.)



PUMPING-ENGINE OF THE LEHIGH ZINC COMPANY, PENNSYLVANIA.—(*See page* 504.)

PUMPING-ENGINE AT THE LEHIGH ZINC-WORKS, FRIEDENSVILLE, PA.

THIS engine is employed to drain the Friedensville mines of the Lehigh Zinc Company. The engine was started in January, 1872, and has since worked without a hitch. In 1853, works for manufacturing white oxide of zinc were erected by the company in Bethlehem, Pennsylvania, under the direction of Mr. Samuel Wetherill, with furnaces and process of his own invention. In 1859, works for manufacturing metallic zinc by the Belgian method were erected by Mr. Joseph Wharton, this being the first introduction of that art, in any form, into this country. In 1865, the company erected a rolling mill for sheet zinc, it being the first introduction of that art into this country; and all these several works have continued in unremitted activity to this day, their capacity being—for oxide of zinc, 3000 tons per year; for metallic zinc, 3600 tons per year; for sheet zinc, 3000 casks per year, respectively—about one half the annual consumption of the country, and of known superior qualities, owing to the unusual purity of our ores. The mines have been worked to meet the demands of the several manufactories, amounting in some single years to 1700 tons, and, in the aggregate, to 500,000 tons of ore, including rich blende, which has been developed in the progress of mining. At a very early day, water was encountered; the company's engineer, Mr. John West, matured a plan of engine, pumps, and shaft for raising 12,000 gallons per minute from 300 ft. depth, and the company contracted with Messrs. Merrick, of Philadelphia, for this new engine, and with Messrs. I. P. Morris & Co. for the pumps, boilers, and mountings. We start with two plunger pumps of 30 in. diameter, set in cisterns 87 ft. down the shaft, one discharging into the adit 25 ft. below the surface, the other discharging into tanks on the surface for condenser and boilers. Below these, two lifting pumps, hung in wire ropes, work to the bottom, 127 ft. below the collar of the shaft, or 122 ft. below the old zero point, or 75 ft. below the level of Saucon Creek, which crosses the road half a mile south. These pumps will throw 735 gallons per stroke—the engine can work comfortably at 12 strokes per minute, and the power is more than adequate, and the dimensions of the shaft (30½ ft. by 21½ ft. in the clear) ample for doubling this number of pumps, and carrying all to a depth of 300 ft., or 178 ft. below the present bottom of the mines, with power still in reserve for what may be required below.

Our engraving shows that, in many respects, the engine is of the Cornish type. Mr. West has, indeed, carried with him from Cornwall the traditions of a successful practice.

It is well known that the Cornish engine can not be worked to any great extent expansively, unless the pits are so deep that a great mass has to be put in motion, in the shape of pump spears, etc. Now the lift in the Lehigh mines is comparatively small, and Mr. West therefore introduced the means of expansive working—that is to say, great mass in motion—in the shape of two fly-wheels. It will be seen that these wheels appear comparatively small in diameter, and nothing will give a better idea of the colossal dimensions of the whole of the machinery than the statement that they weigh *seventy-five tons each*. The beams appear light, but then there are four of them; the holding-down bolts also look slight, but then their number is great. For the following particulars we are indebted to the courtesy of Mr West: "The engine has a pumping capacity of 15 000 gallons per minute, and has been run to 19,000 in case of emergency, raising water from a depth of 350 ft. The engine alone weighs 650 tons, and including the pumps and boilers, the total weight of the machinery is 1000 tons. The cylinder is 110½ in. in diameter; length of stroke, 10 ft. The heaviest pieces of iron in the engine are the sections of beams, which weigh 24 tons each. The fly-wheels weigh 75 tons each; crank pins, 1 ton each. The piston rod is 14 in. in diameter. The crosshead weighs 8 tons. The connecting rods have 9 in. necks, and are 15 in. in the middle, 41 ft. 2½ in. long, and weigh 11 tons each. There are two air pumps, 50 in. in diameter each. The 'President' drives four plunger pumps, each 30 in. in diameter by 10 ft. stroke, and four lifting pumps each 31½ in. in diameter by 10 ft. stroke—the plunger pumps being uppermost and stationary. The lifting pumps are in the bottom of the shaft, and are movable, so as to go down as the shaft is sunk. To handle these lifting pumps, hoisting or lowering them at pleasure, a steam capstan capable of lifting 50 tons vertically is used. By a series of strong gearing, a drum and a steel wire rope, with this capstan, if any thing goes wrong with the pumps, they can be taken hold of by the top and pulled out of water, repaired, and put back in a very short time." The arrangement of the valve gear is rather peculiar. It will be seen that the engine is double-acting. The valves are of the Cornish type, driven by cams bolted on the fly-wheel shaft rigidly. These operate on rolls attached to the ends of levers. There were three sets of steams cams made with the engine to cut off respectively at 9 in., 20 in. and 36 in., to be changed to suit the work, but not adjustable. The speed is regulated by a throttle valve in the steam-pipe with a long arm and wire attached leading down to the bottom of the mine, and there connected to a block of wood which floats on the water. This regulates the engine according to the incoming water. This arrangement is quite new to us, and answers admirably. Mr. West attempted to make a commercial success in preference to an engineering refinement, or he would have tried an adjustable cut-off regulated by a wire and float in the same way. The 9 in. cut-off was first tried, and gave good diagrams. Subsequently, however, the 20 in. cam was put on and worked better, the pressure being reduced; very little more coal was consumed, and the engines ran much more steadily and with less shock. The quantity of water is so great that when the engine is stopped while the shaft or pit is being sunk it will rise up over the suction pipes—wind bores—and valve chambers—clack pieces—in four minutes. This renders it necessary that the provisions for emergency should be very complete.

We believe that the engine is, practically, the largest fixed single engine in the world, that at Harlaem Meer being a compound engine with one cylinder within the other.—*The Engineer.*

A SINGULAR ACCIDENT.

THE laboratory of a *pharmacien* named Martin, at Allanche, in France, suffered a singular accident lately, which may serve as a caution elsewhere. A tin containing about 500 grammes of phosphorus was kept usually on the floor, but an apprentice had placed it on an upper shelf. Somehow, either by evaporation or by accident, this tin lost all its water, and consequently one day the phosphorus took fire. The laboratory and pharmacy were soon filled with suffocating vapors, the cause of which was not traced until afterwards. Engines came, and the fire was at length overcome. Had the accident occurred in the night, M. Martin must have been suffocated, his sleeping apartment being just over the laboratory.

[The Academy.]

THE "CHALLENGER" EXPEDITION.

THE "Challenger" has arrived at last and safely, and it will be part of the reward of her scientific staff, her commander, and crew, to learn how thoroughly their work and endurance have been appreciated by naturalists and philosophers of every civilized country. In calms and gales, in the Antarctic Seas and in the tropical oceans, and under all the pleasures and discomforts of a nautical life, the work which had to be done was done well and to the satisfaction of the distinguished head of the civilian scientific staff, Prof. Wyville Thomson, F.R.S. There appears to have been a most fortunate agreement between the different heads of departments, and when Captain Nares was in England on his way to the Arctic regions he expressed himself without reserve regarding the good fellowship and amiability of his scientific colleagues. Working thus well together, the years spent away from home by the combined staff have become most important in natural history and terrestrial physics; and, indeed, the expedition marks an epoch in the history of the world.

RED CLAY OF THE OCEAN.

When the "Challenger" came into the deep water of the equatorial Atlantic, the staff made a great discovery relating to the vast extent of a red clay on the floor of the ocean at profound depths, and to the comparative absence of life there. This clay, extending as it does far away into the South Atlantic, is found in mid ocean as well as not far from land (where the depth is great); and its red color, the small quantity of carbonate of lime, and large amount of alumina and oxide of iron contained in it, render its formation extremely difficult to understand. It merges into gray ooze to the north, which becomes the well-known Globigerine deposit of the North Atlantic; and to the south the same gradation is noticed, but a remarkable deposit of silicious matters covers the Antarctic sea-floor. If no other result had followed the expedition, this one great fact would have sufficed to make it remarkable; for it throws a vast amount of light on two questions which are intimately connected with the past history of the globe. We have now evidence that the same kind of marine deposit is not collecting universally, but that at least five well-marked sediments are accumulating in one ocean from pole to pole, and that they depend upon definite physical conditions. And there is the proof given to science that hundreds of thousands of square miles of superficial area of deposits are now collecting with but few traces of organisms within them, while the sea above teems with life. What a barrier to the dispersion of many marine forms this clay must be.

In studying the geology of most countries, nothing has been more incomprehensible than the vast extent of red rocks which occur without a trace of a fossil, or with very unsatisfactory evidences of former contemporaneous life; now we know many of them to be of abyssal sea origin.

Again, the succession of one great depth of strata over another, both containing fossils whose modern representatives are marine, both having some kinds in common, is usual enough. The lower one may be silicious in its mineralogy and the upper one calcareous, like the chalk. The most logical theory used to be that which recognized a total alteration in the aspect of nature, and in the relation of sea and land at the close of the deposition of the lowest sediment. But now we know that, were the gray oozes to the north of the region of red clay to be included in one of the many subsidences which have affected the surface of the globe over and over again, they would be gradually overlapped and finally covered by the deep-sea-loving red clay—by a totally different contemporaneous deposit. The exclusion of great periods of time and of great general physical and biological revolutions is thus possible by adopting this theory of partial subsidence and overlap.

A concurrent discovery, ably worked out by the chemist of the expedition, and well (but not without opposition at home) elaborated by the chief of the staff, materially assists the comprehension of the cause of the comparative absence of organic remains in the red clay. The amount of carbonic acid gas held in suspension by the sea at great depths is very great, and it acts as a solvent on carbonate of lime passing through the zones of depth where it is most abundant. Now, there is no doubt that a perfect rain, down the depths, of floating and swimming things occurs day and night, of things once alive, which settle down gradually into their mighty grave. But their atoms are not always destined to rest in mother earth, for coming within the intervening space they suffer corporeal dissolution, and their molecules are wafted far and wide as a liquid—as carbonate of lime with an attendant spirit in the form of a corresponding amount of carbonic acid. Even those which reach the clay have suffered loss of substance, and then they are altered by the mineral matters of this remarkable earth and still further changed from their original form.

TEMPERATURE OF THE OCEAN.

Equally important with this discovery has been that of the universal lowering of the temperature of the large seas with increase of depth, and this verification of the work of the former expeditions is very satisfactory. It completes a very important portion of the physics of the earth, and its biological bearing is immensely interesting. Cognate to this subject are the results of the soundings, and those of the "Challenger" have yielded the deepest in the Atlantic, and have verified those of the "Tuscarora," to a certain extent, in the Pacific; but those of the "Challenger" will ever remain as the correct data upon which future work will be done. Including, therefore, these separate investigations in one great series, it is not too much to say that the path of the "Challenger" gives us a very fair, and, so far as it goes, perfectly accurate idea of the nature of the slopes, hills, vales, and plains at the bottom of the sea—of their soil, of the temperature and pressure of the sea on and about them, and of its living and dead things. Of the treasures which have been fished, trawled, and dredged, not much is known at present, they are packed up, and their restoration to light will be for the edification of naturalists; but every now and then, when any very important "find" was made, the results of the examination were sent in the form of communications to the learned societies; when they have excited a vast amount of satisfaction, and not a little debate. The discovery and description of living forms are now of threefold importance, and they are not matters of simple wonder-mongering as of old. Every newly discovered shell, animal, sponge, or urchin fills up a gap in the great scale of life, and has its zoological importance. Then this position is comparable with that of others, and perhaps of the same species, in the zoology of the past histories of the globe, and thus the entity has a palæontological bearing; and, finally, in both of these aspects it is related to an ancestry and has all sorts of affinities of structure, and thus helps to verify the great doctrine of Evolution.

ANIMAL LIFE AND REMAINS AT THE BOTTOM OF THE OCEAN.

One of the most important of the results of the expedition which preceded that of the "Challenger" was the discovery that the fauna of the deep sea contained species, genera and groups which existed during past ages, and which have survived the more or less important alterations that initiated and terminated the subsequent so-called geological periods. This at once gave every form from the depths of the sea a palæontological and philosophical value which was not diminished by the inferences which could be drawn by comparing from the analogy of nature the conditions of the past and present seas. There are examples of this wonderful persistence of forms, and, therefore, of an unbroken succession of generations, to be noticed in the natural-history details already described by the staff of the "Challenger"; and, doubtless, as the vast collection made during the voyage is carefully examined, there will be many more. All this tends to explain the great age of many forms of living things, to link together the past and the present, and thus to give many a shell and coral dredged up with all the skill and appliances of modern ingenuity its proper history in the progressive evolution of the globe. It has been now proved that most animals living on the floor of the deep seas have great ranges, and many are found over widely separated parts of the sea-bottom; and it is especially these which have a great antiquity in the history of the world. And it is certainly remarkable that this vast range in the horizontal direction, and in the vertical also, should have been noticed in the days before life was believed to exist at profound depths, by the advanced geologists of the school of Edward Forbes. When geologists found a kind of fossil in strata which had a very wide extent—for instance, in England and India—it was almost sure to be found in several consecutive deposits, and thus a proof was afforded that these widely dispersed forms of old lived long and persisted as their much later congeners do. But while some animals are thus widely diffused, others noticed in this and the former expeditions are restricted to definite localities. Their importance is, however, quite as great as that of those just mentioned, they form the special creatures of the distributional provinces of the naturalist, and the cause of their limitation comes within the province of the physical geographer. Moreover, these endemic forms are eagerly studied by those who interest themselves in the history of the latest geological ages, for it is by comparing the extinct and the existing faunas that something like an opinion may be offered regarding the last grand epoch of our globe. These considerations have evidently been always before the staff, and it is to be hoped that the work of describing and determining the "Challenger's" treasures will be put into the hands of those who will be also influenced by them.

A CURIOUS CRAB.

Some very curious forms of life which have no particular relation with the past have already been noticed by the staff, and very early in the cruise some very extraordinary crustacea were described. One, which apparently kept down at a considerable depth during the day and came up to the surface at night, was certainly one of the oddest of the odd among the eccentric crab tribe. Its head was nearly all eye, and each eye was composed of a host of lenses; there were not only five pairs of good legs attached to the body, but three pairs of false legs lower down; moreover, there were three pairs of branchiæ or gills, and also appendages to the tail. It had two pairs of foot-jaws, and the whole was so transparent that the muscles, nerves and great internal organs could be readily distinguished. Another crustacean, more lobster-like than the other, was without eyes, but it maintained its singularity by having some structures which hitherto had only been found in two genera instead of one.

SEA URCHINS.

The two remarkable urchins which were dredged up in the "Porcupine" expedition, *Salenia* and *Pourtalesia*—the one a remnant of the days of the chalk and the other a most unusual shape, with cretaceous tendencies—came up in the dredges of the "Challenger," the last over a wide area. A great Hydroid as large as a young tree was fished up, and many sponges of exquisite beauty. Moreover, Globigerina, that kind of foraminifer whose shape is now so familiar to the most unscientific, turned out to have, under the careful examination of surface specimens, a beautiful spiny coat surrounding the holes through which the contractile and motile, yet structureless, protoplasm protrudes.

GENERAL RESULTS.

Of the details of the fish, reptiles, and of the botany little is known at present, and doubtless the geologists will soon hear the results of the examination of out-of-the-way places. But the composition, specific gravity, temperature, and movements of the sea, worked out as they have been with great care and skill, have been more or less before the public. In fact, ever since the "Challenger" started on December 21, 1872, up to her last week, meteorological and physical researches and observations were carried out by the thousand. The Atlantic was crossed and recrossed in the first year, so that including the return voyage home, that ocean has been traversed many times. The position of the particular deposits with regard to depth was settled early, and then the deepest Atlantic sounding was made, nearly ninety miles north of the Island of St. Thomas, in 3875 fathoms. So great was the pressure of the water at this immense depth that the bulbs of the thermometers, which had been made to stand a pressure of nearly three tons, broke. This great depth, like all other great depths, was not remote from land, and was near a district famed for its former volcanic energy.

The "Challenger" had a refit at the Cape after her long voyages in the Atlantic, and Mr. Moseley, one of the naturalists, found there and examined a very remarkable insect, belonging to the Hundred-legs group, and the results of his work were published in the *Philosophical Transactions* of the Royal Society. It has a remarkable defect in its construction—that of having a very important organ occasionally strangulated by a kind of knot tying it. In the voyage to the Australian coast, and thence to the regions of ice to the south, a vast collection of silicious cells of Diatoms and Rhizopoda was observed to cover the sea floor. Sketches of icebergs were taken, and then the expedition sought warmer latitudes.

After remaining some time in the Australian seas, and, it is to be hoped, obtaining abundant specimens of the marine fauna, the expedition left Port Nicholson in July, 1874, and sailed to New-Zealand. Trawling in 1100 fathoms with a bottom temperature of 2° C., the floor being a greenish ooze, they brought up animals resembling those found at corresponding depths in other portions of the southern seas. Then proceeding northwards towards the Kermadec group, they fished up forms of living things having a general resemblance to what may be got from the same depth off Portugal

or North Africa. Then going by way of Tongatabu to the Fijis, they obtained a living specimen of the Pearly Nautilus, and observed its movements and attitudes. The reefs of the islands were well searched, and the natural history of the groups was examined. Prof. Wyville Thomson notices the depths between New-Zealand and the group particularly, inasmuch as only two soundings were taken of depths greater than 1000 fathoms. One gave a depth of 1100 fathoms, and the second 2900 fathoms, this last being 25° S. of the equator; the temperature in the first instance of the bottom water was 3° C., and at the greater depth below freezing, or 0·5° C. Serial temperatures were taken also, and it was shown that the open Antarctic seas had the cold under-current and the warm surface, as in the case of the oceans to the north. A great similarity was observed in moderate depths in respect of the animal forms. After this the "Challenger" was in the neighborhood of Torres Straits, and then the red clay was got at a depth of 2650 fathoms, and south of the equator, the temperature being very low on the floor.

The Melanesian Sea was visited, and then they proceeded across the Arafura Sea, with its shallow waters and dwarfed fauna. Then they shot Birds of Paradise, and a few days after dredged up those beautiful sea-lilies the Pentacrini—the very luxury of a natural-history trip. Thence the "Challenger" wandered through the Celebes Sea to Zamboanga, and here Mr. Moseley made some most important observations on a kind of coral whose position in the recognized classification had been a matter of doubt. Finding this Heliopora, which greatly resembles some of the very oldest forms of life, to be not a true coral, but an Alcyonarian, he attempted to settle the knotty question regarding the nature of the millipores, but had to leave their consideration until better specimens were obtained. This is probably the most important part of the voyage to naturalists. After visiting Hong Kong, and proceeding to Japan, they got the greatest depths in the Pacific, 3950 fathoms, with a bottom of red clay, about 5° east of Yeddo, and then they went due east and turned south to the Sandwich Islands. The dredge brought up many curious matters—for instance, large lumps of oxide of manganese, and sharks' teeth, and the ear-bones of whales—and the temperatures of the surface and of the bottom were as usual very different. Sailing across the ocean desert to Juan Fernandez and Valparaiso they passed through the Straits of Magellan on their homeward voyage.

Only one of the scientific staff does not return, except in the memory of his fellow-laborers, but Von Willemöes-Suhm's name will last as long as science.

A great expedition has thus returned after having done its duty, and the country may well be proud of it. The consciousness of having participated in this will be no small reward to all who have served on board. It is to be hoped that a very decided recognition of the services of the scientific staff will enable the Government to depart from their usual neglect of giving rewards, social and others, to prominent scientific men. But it is of great importance to the public that a good, concise, and cheap work shall soon be placed before them on the subject of the Deep Sea; and to do this every attempt should be made to have the "Challenger" collections named and described forthwith.—*P. M. Duncan.*

[The Academy.]

THE LOAN COLLECTION OF SCIENTIFIC APPARATUS.

Section I. Arithmetic.—In this section visitors will be chiefly interested in the calculating machines, of which there is a series, beginning with that invented by Sir Samuel Morland in the seventeenth century, and designed for trigonometrical computations, and including Pascal's machine (date 1642), lent by the Conservatoire des Arts et Métiers; the celebrated difference machine of the late Charles Babbage, F.R.S., left unfinished in 1833, and Cavendish's original counting-machine. Here also is Sir William Thomson's tide-calculating machine, which was exhibited and described at the last meeting of the British Association. With this instrument curves are drawn which predict the height of the tide at a given port for all times of the day and night, with as much accuracy as can be obtained by direct observations.

Section II. Geometry.—A number of pantographs—instruments for drawing any plane figure upon a different scale—are exhibited: they are chiefly of foreign construction. Among instruments for tracing special curves we may mention Dr. S. Zmurko's cycloidograph, an instrument for the practical description of cycloids; Mr. Perigal's geometric chuck, with diagrams of curves obtained by it; a beautiful apparatus invented and constructed by Mr. A. E. Donkin for compounding two simple harmonic curves: in this instrument a glass pen moving backwards and forwards over a strip of paper wound round a cylinder draws one of the curves, and a similar motion of the cylinder in a parallel direction produces the other; since both move at once the curves are combined, and the result rendered visible by the motion of the cylinder. Here will be seen the very fine collection of models of ruled surfaces made by M. Fabre de Lagrange, in 1872, for the South Kensington Museum; a series of cardboard models of surfaces of the second order (the cone, the cylinder, the ellipsoid, the hyperboloids, and both the paraboloids), exhibited by Professor Henrici and by the Royal Polytechnic School at Munich.

Section III. Measurement.—The first thing to notice in this section is the interesting collection of standard measuring apparatus, contributed by the Standard Departments of the Board of Trade. Of these several were used by Mr. Sheepshanks and Professor W. H. Miller, in the work of the Commission for the Restoration of the Imperial Standards, after the disastrous fire which destroyed the Houses of Parliament and the standards which were there deposited, in 1834. There is a comparing apparatus for end-standards of length, by which a difference of one ten-thousandth of an inch could be measured; an apparatus for determining the expansion by heat of the standard bars; a spherometer, for measuring the flexure of the middle of the glass disc pinced upon the imperial standard bushel; one division of the micrometer of this instrument is equivalent to 0.0001 inch; but by a special artifice it could be made to measure accurately to 0.00001 of an inch. A gilt steelyard, the defining lines of the yard being traced upon gold studs sunk into holes cut into the bar, is an example of the original yard line measure. Standard end-measures are exhibited also. The collection of standard weights includes a one pound avoirdupois weight of gun-metal coated with nickel, one of the numerous experimental standards constructed by the Commission above referred to; also British and metrical weights made of brass, gun-metal, iron, and glass. The Royal Society contribute Bird's and Shuckburgh's standard brass scales, and there is also a brass scale of forty-one inches divided into tenths, and of a mètre divided into millimètres. This possesses some scientific interest, having been compared several times with Shuckburgh's scales by Capt. Kater. The Mayor and Corporation of Winchester have contributed their valuable collection of old standard measures. Among them is a set of standard weights of Edward III., and standard weights (both troy and avoirdupois) of Queen Elizabeth. Sir Joseph Whitworth exhibits his hexagonal surface plates, a standard screw gauge, standard difference gauges, a measuring apparatus graduated to measure one ten-thousandth of an inch, and, lastly, the instrument by which it is said a difference of one millionth of an inch can be measured: in this instrument a "gravity piece" bounded by two true planes is introduced between the end of the piece to be measured and one of the end surfaces of the machine, and a motion of the screw of one-millionth of an inch determines whether the gravity piece shall be held by friction or fall by its own weight.

In this part of the collection we find, oddly enough, the apparatus used by Dr. Joule for measuring the mechanical equivalent of heat—the revolving electro-magnet used in 1843, the paddle-wheel, and the friction disc apparatus.

Among the cathetometers is a useful form, with massive iron frame (one of the chief requisites in an instrument of this kind), made by Casella and contributed by Prof. Rücker, of the Yorkshire College of Science. Another, inferior in some respects, is sent from Gratz by Prof. H. Streintz. A cathetometer of an older type, with cylindrical brass column, but capable of very accurate measurements, will be found among the instruments contributed by the Standards Department.

Of balances there is a goodly array, some of the finest being contributed by Oertling; balances to weigh to .001 of a grain, with long beams and short beams, assay balances, a tangential balance for measuring the specific gravity of a liquid by the inclination of the beam, vacuum balances, a balance which formerly belonged to Dr. Priestley. The largest, in a case by itself, is sent by Prof. Rijke, of Leyden, and was constructed by Olland, of Utrecht. In a series of experiments made with this instrument with weights of fifty kilogrammes the numbers did not differ in the average by more than 0·5 milligramme. Two dynamometers sent by Prof. Hennessey indicate force in absolute measure. There is a considerable number of clocks, watches, chronometers, etc., which are interesting, some historically, and others as exhibiting the latest developments of mechanical skill in this department. A clepsydral escapement for a clock, by Prof. W. H. Miller, will attract attention; the pendulum motion is maintained by the transference of a drop of water from a higher to a lower level at every vibration.

Section IV. Kinematics, Statics, and Dynamics.—From Leyden is a collection of apparatus used by Gravesande for demonstrating the laws of falling bodies, the theory of the wedge, etc. Of instruments for illustrating wave motion and the composition of vibrations we may notice the following:—Wheatstone's apparatus, showing plane, circular and elliptic waves, the phenomena of interference, etc; an ingenious contrivance, by Mr. C. J. Woodward, for producing wave-motion; a pendulum apparatus for the graphic representation of the combination of rectangular vibrations, sent by the Physical Science Institute of the University of Halle; in this instrument two pendulums vibrate in planes at right angles to each other, a pen being attached to the upper part of one, while the other carries a platform on which is stretched a sheet of paper; when both pendulums are swinging, the curves traced on the paper partake of the motion of both. With this instrument may be compared that devised by Mr. Tisley for the same purpose. In the latter (which is by far the simpler of the two) the tracing pen is connected at once with the upper parts of both pendulums, while the paper on which the curves are drawn is stationary. Some exquisitely beautiful curves, drawn in this way, accompany the instrument. There are various machines for the experimental demonstration of the laws of falling bodies. One of these is Morin's apparatus, in which the downward motion of a weight carrying a pencil was combined with the horizontal motion of the paper with which the pencil was pressed in contact. Another is an Atwood's machine, lent by the Council of the Yorkshire College of Science, in which the time of fall is measured by a water clock, the orifice of which can be opened or closed by an electro-magnetic arrangement. A description and explanation of the extensive collection of kinematic models exhibited by the Royal Technical Academy of Berlin will be found in Prof. Kennedy's translation of Reuleaux's *Theoretische Kinematik*.

Section V. Molecular Physics.—Under this head will be found included air-pumps and pneumatic apparatus. Of these the most interesting is the original air-pump of Otto von Guericke and the two famous Magdeburg hemispheres; they are in a glass case close by the south entrance to the upper west gallery, and are accompanied by a copy of von Guericke's book, *Experimenta nova (ut vocantur Magdeburgica) de vacuo Spatio* (1672). Other air-pumps of historical interest are, one by Van Musschenbrock from Cassel, and one of the Abbé Nollet from the Conservatoire des Arts et Métiers. The gradual improvements made in the air-pump are illustrated by diagrams of Torricelli's vacuum, von Guericke's pump, Hawksbee's, Boyle's, etc. Among the modern pumps is a good one by Spencer & Son, of Dublin, lent by Prof. W. F. Barrett. There are various modifications of Sprengel's mercurial pump. Close by will be seen the original machine used by Thilorier for liquefying carbonic acid, Papin's compression engine, and the apparatus used by Dr. Andrews in his researches on the continuity of the liquid and gaseous states of matter.

Section VI. Sound.—Directly opposite the air-pumps will be seen the musical and acoustical instruments. Here is the enharmonic harmonium of Mr. R. H. M. Bosanquet, with its bewildering key-board, tuned according to the division of the octave into fifty-three equal intervals; various other harmoniums designed with special objects; and a collection of musical instruments, interesting scientifically as well as musically, contributed by Dr. Stone. Perronet Thompson's enharmonic organ stands at the top of the staircase as you enter the gallery. Close by is Mr. Baillie Hamilton's stand of apparatus illustrating the progress of æolian principles; a set of Mr. Francis Galton's whistles for testing the limits of the power of men and animals of hearing very shrill notes, each tube having a scale attached by which its length can be measured when the shrill sound becomes inaudible; an apparatus for determining the inferior limit of audibility; Tyndall's apparatus for showing the reflection of sound by vapors and heated air; models of Egyptian pipes, the originals of which, found in Egyptian tombs, are now preserved in the British Museum; several examples of Helmholtz's double siren; and the spoon-shaped apparatus used by Colladon in 1826 for investigating by direct measurement the velocity of the transmission of sound in water.

Section VII. Light.—Here is the reflecting stereoscope of Wheatstone; also Wheatstone's wave-machine, the object of which is to exhibit the results of the interference of polarized light; Becquerel's phosphoroscope; and one of the earliest of Brewster's kaleidoscopes. Of spectroscopes there is a great variety, of which we may mention the following:—Spectroscope by the Rev. N. Brady, in which prisms are cemented to the object-glasses of the telescope and collimator, one by Browning with six prisms through which the light may pass four times by three successive reflections; another by Mr. Brady with special arrangement for diffraction spectra; direct vision and pocket spectroscopes; spectrometers and goniometers from Göttingen; and the universal instrument constructed by Lutz of Paris for almost any investigation connected with the reflection and refraction of light. The subject of polarization is well illustrated. There are polariscopes with Nicol's prisms and on Norremberg's plan; Jellet's saccharimeter; De la Rive's apparatus for measuring the magnetic rotatory polarization of liquids; polariscope for projection with a pair of large Nicols, used by Dr Tyndall in America, and contributed by Mr. Spottiswoode, to whom is due also another very large Nicol, and Wheatstone's polar clock, in which the hour angle of the sun, and consequently the local time, is approximately determined by observing the plane of polarization of the light from the sky. A diffraction bench of Jamin is here, and the improved form designed by Prof. Clifton; also a set of Nobert's gratings, glass plates having a large number of very fine lines ruled upon them, for the production of diffraction spectra. The detached cases contain a good collection of prisms and lenses of crown and flint glass, quartz, and Iceland spar; glass cells and prisms for liquids; two large spheres of Iceland spar, contributed respectively by Mr. Spottiswoode and Prof. Maskelyne; Nicol's prisms, double image prisms, and Rochon's prisms. Lastly, we must not forget to mention the apparatus used for the direct determination of the velocity of light; the rotating mirror and clockwork of Foucault, the toothed wheel and telescopes of Fizeau's method, and the rotating mirror and reflecting mirrors used quite recently for the same object by M. Cornu.—*A. W. Reinold.*

EFFECT OF ELECTRICITY ON PARTICLES SUSPENDED IN LIQUIDS.

SOME interesting observations on this subject have recently been described by M. Holtz in *Poggendorff's Annalen*. A "wandering" of particles suspended in a liquid, when submitted to electric currents, has long been known of, and was fully studied by M. Quincke. M. Holtz finds that in all cases of such motion, there is at the same time a clinging of particles to one of the poles, and this often with such precision that one might construct an electroscope on this principle for ascertaining the polarity. Especially notable is the tendency of *Semen Lycopodii* in insulating liquids, particularly sulphuric ether, to cover the negative pole with a thick coating, while sulphur, cinnabar, or sulphide of antimony in the same liquid only coat the positive pole. A simple medicine glass even suffices for the experiment, a conductor or half conductor being introduced through the stopper. The glass is held in the hand, and the conductor brought to an electric machine: the phenomenon then occurs. It is more suitable, of course, to have the bottom perforated for insertion of the second pole, or to use an open glass with the two poles pushed down into it. Either a frictional or influence machine may be used.

M. Holtz did not, like Ilirgensen and Quincke, use capillary tubes, but wide vessels, and this, he thinks, may be the reason why many substances—for example, sand, manganese, sugar, etc.—seemed to be quite indifferent, neither wandering nor adhering to the poles. But here occurred another interesting phenomenon, if the bottom of the vessel were straight and smooth, and not rendered conducting by a layer of moisture condensed from the air. For the particles formed figures, under the action of the electric current, of very various character according to their size and structure, and according to their own conductivity or that of the liquid. Figures of extraordinary fineness and regularity, and quite corresponding to those assumed by iron filings under action of the magnetic poles, were obtained with finely pulverized manganese, emery, and oxide of iron, in petroleum, oil of turpentine, benzine, and sulphuric ether. Still finer, and consisting of largely entwined lines, were the figures from reduced iron; but extremely little of this substance must be used, owing to its great conductivity. The figures formed of sawdust were more regular, and branching like trees. Cinnabar in ether gave a cloud-like form which, on account of the polarity referred to, surrounded the positive pole. Sugar and bran mostly formed thick connected skeins, through which the electricity then flowed as by a conducting bridge.

In very few cases, however, is the figure stable during the electric action. In general, while the figure does not essentially alter in character, one may readily distinguish in it a double movement, first a thrusting to and fro of the separate particles within the lines they form (and this motion is stronger the larger the particles and the smoother their surface); then a continuous displacement of entire lines vertically to the connecting line of the poles, and this apparently more outwards if the electric current is strong, more inwards if it is weak. This latter motion, however, frequently becomes of a rotatory character, the connecting lines sometimes breaking, and each part for itself tending to circle round the pole to which it adheres. Such circular motion occurs in greater measure with cinnabar, sulphide of antimony, and some other matters, which generally do not form connected lines. It appears in a peculiar balling together and gliding forward of separate parts.

But the circular movement is greatly favored if a wire ring be taken for one pole, and the other pole be placed in the centre of it. In this case, naturally, the external form of the figures is altered, and in most instances, whatever the polarity of the central conductor, one obtains figures which in their radiating structure resemble the Lichtenberg figures. With those materials which do not form connected lines, the circular motion now becomes so distinctly the prevailing one, that the figures produced fully correspond to the negative Lichtenberg figures.

The rotation-phenomenon was best obtained in a glass 200 mm. high and 100 mm. diameter, having a perfectly even and smooth bottom, and which had not been used for previous experiments. In the axis was fixed a wire which, with its lower point, touched the middle of the bottom, and (the glass itself standing on a conducting base) was slowly and constantly electrified with one pole of an influence machine. M. Holtz describes in detail the effects obtained when this vessel was charged after the fashion of a Leyden jar.

Another not uninteresting phenomenon in some of the above experiments was the cone-shaped rise of the liquid on the immersed wires. This takes place to greatest degree on the negative pole, and with sulphuric ether. It is intimately connected with the polarity of the suspended particles, for through adhesion of these to the one pole the rise of the liquid on the other pole is favored. M. Holtz hopes to study the phenomenon further.

LESSONS IN MECHANICAL DRAWING.

By Prof. MACCORD, STEVENS INSTITUTE.

(Continued from page 476)

No. XVI.

ALL that has been thus far said, it will have been observed, has related to the drawing of plane figures, except some incidental instructions in regard to the use of shadow lines as a means of giving relief, or the appearance of solidity, to outline drawings. It is now time to combine with these line exercises the actual representation of solid objects.

As a preliminary, it is necessary to get a clear idea of the relations between the drawing and the thing drawn, and the manner in which the one represents the other. Probably none of our readers need be told that there is a great difference between a perspective picture of a steam engine, for example, and a working drawing of the same. Yet each represents the same thing, the one may be as accurate as the other, and both are mechanical drawings, in the sense that they are made by scale, rule, and compass. It is true that the working plan is very frequently designated as "mechanical" by way of distinguishing it from the picture; but since they are both executed mechanically, it is clear that this distinction is an erroneous one. In what, then, does the difference between the two, which is palpable and decided, consist, and to what is it due? The distinction lies in the fact that the object is represented under different circumstances in the two modes of drawing it; as it is very often expressed, in the perspective the object is drawn as it *seems*, in the other it is drawn as it *is*, which,

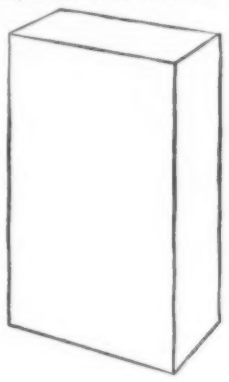


Fig. 143

though not perhaps the clearest or best way of putting it, is true in the main, as we shall try to show.

Let us take as a model, or subject to be drawn, a block of wood, or a paper box, with flat sides and square corners, say 8 inches in length, 5 in width, and 3 in thickness. Such an object is represented in Fig 143, which is a perspective drawing, and conveys in one view a clear idea of the proportions and the form.

In looking at the figure, we are conscious that the block is bounded by rectangular faces, but the angles in the drawing are not right angles; we feel that the opposite sides are equal and parallel in fact, although in the picture they are neither the one nor the other. And we know that we could place a block of the dimensions given in such a position that it would look precisely like this drawing which, therefore, represents it as it seems.

But we know, too, that if we gave this drawing to a carpenter, and asked him to make a block of precisely that size and shape, he would laugh us to scorn, and serve us right,

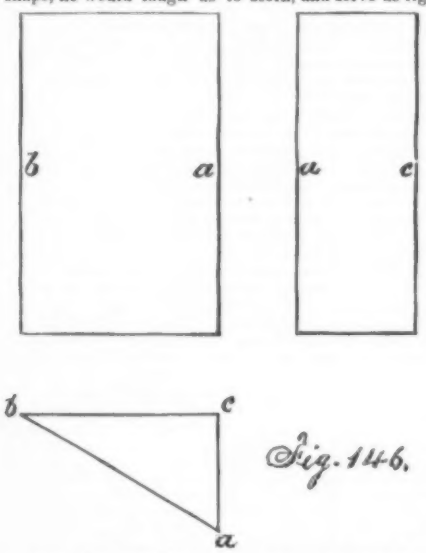


Fig. 146.

here are three lines which we know are equal, and he knows we know it, and no two of them are drawn of the same length: right angles of various sizes, some obtuse, some acute; and the thickness growing small by degrees and beautifully less, which in point of fact is uniform throughout. This drawing, then, although it appears, and is, perfectly correct, and conveys a clear and accurate idea of the appearance of the object, is of no practical use to the workman; the form and dimensions are *represented*, but not *given*.

But we observe that we see three of the six faces by which the solid is bounded; and reflecting on this, we correctly conclude that in order to get the block made, we must in some way convey a positive knowledge of all that is represented in this view of the three faces—that is to say, of their actual dimensions, forms, and relations

Now, let us place a sheet of transparent paper in contact with the front face of the block, and mark on it the visible outlines, as shown in Fig. 144, A.

This rectangle perfectly represents that face; we see that its opposite sides are equal and parallel, they are drawn in their true length, and the angles of their true size. But though we know the height and the breadth, we have as yet no clue to the thickness. Let us then next go round to the right-hand side of the block, place the paper against that face, and again trace the outlines, as at B in the same figure. Here again we have an exact and complete representation of the face under consideration, and this new view tells us the height and the thickness. Something is, however, yet lacking; from these two views alone, we could not determine whether the vertical corners of the block are square, or rounded off. So in order to remove all doubt, we lay the paper on the top, and trace the outlines as before, as shown at C, giving a third view, in which we see the breadth and thickness, and the exact form of the upper end of the block. We have then, finally, a group of views, of which neither one, nor either two, will suffice fully to define the object represented, but the three taken together do define it with perfect

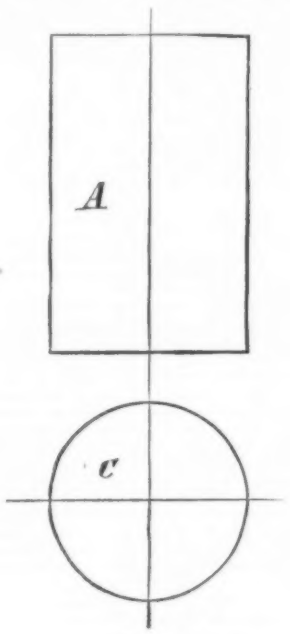


Fig. 145.

precision, so that from the information conveyed by them it can be constructed Hence it is manifestly proper to speak of such representations as "working drawings;" and it will be observed that in each one of the group the face which is shown is represented as it *is*.

These views are technically distinguished as follows: A is called the front, or side, elevation, B the end elevation, C the plan, or top view, and the three collectively are called a drawing. It may be remarked in passing that the term 'a drawing" includes all the views, whatever their number or nature, which are necessary to the complete representation of the object.

The purpose is to give full and clear explanation; and a drawing is complete when it contains all the information requisite to enable the workman to make what is represented, and not otherwise, no matter how accurate or elaborate the execution of what is drawn. If this information can be conveyed in a single view, as in the case of a pattern by which to cut out sheet metal, well and good; if not, we must increase

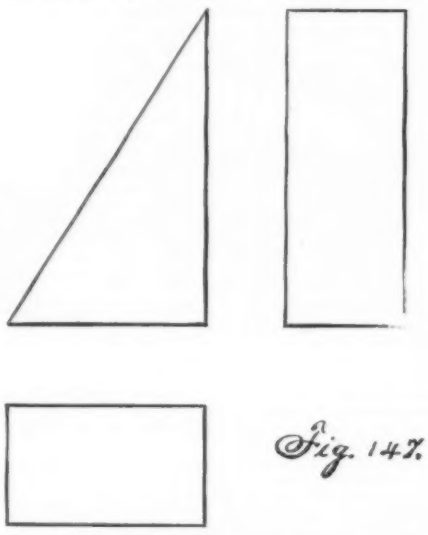


Fig. 147.

the number of views until that end is attained. It is of course to be understood that we are now speaking of working drawings only; illustrative plans, of whatever kind, are not subject to this rigid rule, for it is evident that the general arrangement, and the mode of action, of a machine, might be made perfectly intelligible by means of drawings which would be quite sufficient for building it.

Now let us study the drawing, Fig. 144, and examine more fully the relation between the three views of which it is made up, and the object which they represent.

We described it as being made by placing the paper against the faces of the block in succession, and tracing the outlines, supposing the paper to be transparent and in each instance placed against the side of the block nearest us; but the same results would have followed if we had placed the back of the object against the paper, the latter being opaque. That is to say, the rectangle A, for example, represents either the front or the back, or more properly both. As above remarked, this view conveys no idea of thickness: by itself it might represent a thin sheet of metal, and the side view in that case would have been a mere line, like one of the vertical ones in B; and it is easy to see that it would represent such a sheet just as well, whether we suppose it to lie on the paper, to be some distance in front of it, or some distance behind it. And if we add another sheet, doubling the thickness, it will not alter this view in any particular; thus we may go on, until we build up a block of the thickness shown in the side view B. It is not, then, necessary to imagine that the paper touches the object at all; what is required is, that in making the view A, it shall be parallel to that face; and that the outline marked on it shall be directly in front of or directly behind the actual outline of the face itself.

This may be seen from another point of view, thus: if we suppose A to be a hole cut in the paper, it is obvious that the block may be passed through it, keeping it always in such a position that its front and back faces shall be parallel to the paper, and it will just fit the hole all the time; and if it were first placed at any distance from the paper and then moved, or projected, perpendicularly towards it, it would make just this rectangular hole in the paper in passing through it. So with C, the top view: if we hold the block perpendicularly over it, and let it fall, it will punch a hole just large enough to allow the body to go through, and would do so in any case; in the present instance the body is of uniform size and shape from end to end, and the ends are planes parallel to the paper, and consequently the opening corresponds in form and dimensions to the end itself.

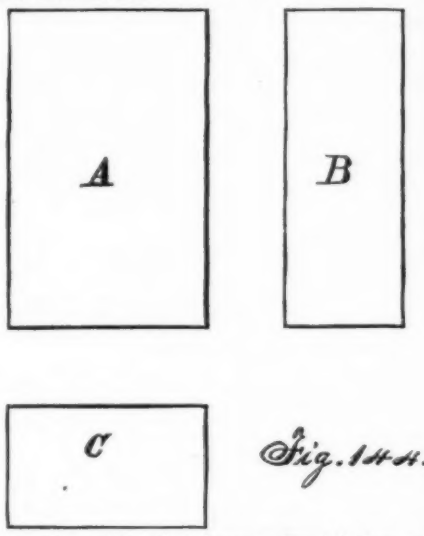


Fig. 144.

The outlines of the object shown in Fig. 144, then, may be obtained in two ways: by placing the paper in actual contact with it and tracing them, or, by placing the paper parallel to the faces one after the other, and supposing the body to move perpendicularly toward and through it, in which case the openings made by it would be bounded by the same outlines. The latter idea is the one which we wish the student to impress firmly on his mind; for though in this instance it seemed more direct to work in the other way, it is easy to see that in many cases it would not be practicable. For example, suppose the block to be cylindrical, as shown in Fig. 145; we may consider the top view, C, as obtained in either of the ways above described, but the side elevation, A, evidently can not be made in the first manner, since there is no front face, properly speaking, as there was to the first one. We may place the block in contact with the paper, but it will touch it only along a line in the centre of the rectangle, which we know properly constitutes the outline of the representation in that position. But if we imagine the cylinder to be placed

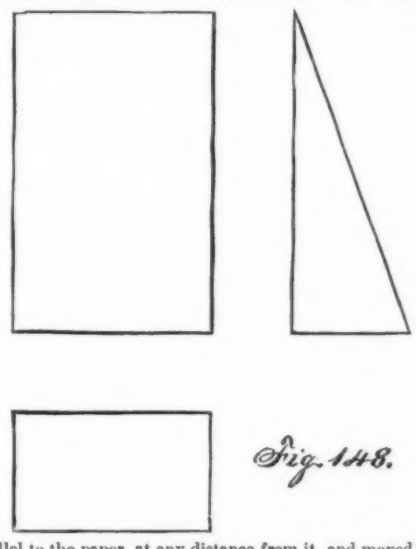


Fig. 148.

parallel to the paper, at any distance from it, and moved perpendicularly, so as to pass entirely through it, it is clear that the opening made by it will be rectangular, and precisely large enough for it to go through; and in like manner the circular outline of the top view may be formed. This figure, by the way, illustrates the case in which two views are enough to define an object—as it obviously makes no difference which side of the cylinder is in front, all sides being parallel to the paper and equally distant from the centre-line or axis, the *elevation* will necessarily be this rectangle, whether it be a front or a side view, one of which therefore suffices.

We deduce, then, this relation between the drawing and the object: that the body is so situated that each of the visible outlines is perpendicularly in front of or behind its representation on the paper. In this lies the essential peculiarity of these drawings, and the student must endeavor to fix this firmly in his mind, and to realize the fact that a line on the paper represents one which may be at any distance from it, but is always situated so that a perpendicular to the paper from any point in the actual line will pass through its representation.

This is apparent in the drawing of the cylinder; but it may be seen in another way in Fig. 146. Here it will be observed that the front and the side views are precisely like those in Fig. 144, yet the object is of quite a different form. But recollecting that neither view by itself conveys an idea of more than two dimensions, it will readily be seen that if we look at for instance the front view alone, we have nothing to assure us that the body is of uniform thickness; and on looking at the top view, we see that it is not—the right side, *a*, is nearer to us than the left side, *b*. We find from this top view, also, that the edge *a* is directly in front of another edge *c*, which is therefore represented by the same line in the front view; but in the side view these two edges *a* and *c* are just as far apart as they are in the top view.

Now, regarding the triangle *a b c* in the top view as the outline of one end of the block, it will be seen that the line *a b* lies directly in front of the line *b c*; it is therefore represented by the same line in the front view, which is either the upper or lower outline of the rectangle, as we choose to regard *a b c* as the top or the bottom of the block. Yet *a b* is longer than *b c*; the reason why it appears of the same length in the front view is, that *b c* is parallel to the paper, so that we look at it perpendicularly; but *a b* is inclined to the paper, and consequently seen obliquely. It is sometimes difficult for the beginner to realize this apparent shortening of a line; a good and ready illustration may be made if he will hold his triangle vertically, so that its shortest side rests on the table, and imagine himself to be directly above and looking down upon it, when he will notice that the longest and the shortest sides will appear of the same length. And he will also notice that the other one, which stands upright, will appear as a mere point, coinciding with the end of the base on the table.

This also is illustrated in Fig. 146, since the side *a c* of the triangle *a b c* appears in the front view as merely the upper or lower extremity of *a* in that view. In fact, this figure presents the identical illustration above suggested, only that the triangle is supposed to lie horizontally, flat on the table, and to be viewed from the front, the eye being on the level of the table.

In order to make the student familiar with this relation of things under different circumstances, we introduce Figs. 147 and 148; in the first the side and top views are the same as in Fig. 144, but as the former conveys no information about the breadth, and the latter none about the height, we find ourself at a loss until we consult the front elevation. It might at first seem as though we should ascertain the height from one and the breadth from the other, and as the thickness is given in both, that thus we should know all about it. But the side elevation gives us the *extreme* height only—it does not tell us whether it be everywhere the same; and the front elevation plainly indicates that a serious error would result from taking it for granted that it is so.

In Fig. 148 we have again two views—the front and top—identical with those in Fig. 144. In the same way as before, we find the information given by them defective: we get a good deal, to be sure, but still we are not certain whether either the height or the thickness is uniform; and the side elevation is necessary to tell us that neither of them is, as well as precisely how they vary.

In all these illustrations of objects bounded by plane surfaces, we have adhered to the uniform proportions of eight in length or height, five in breadth, and three in thickness, for the express purpose of making two of the three views of each wedge-shaped piece identical with the corresponding two views of the one shown in Fig. 144, and thus more emphatically calling attention to the fact that, in general, three views are necessary, in order to determine the three dimensions beyond the possibility of a doubt. The drawings made in this way are technically called *projections*. We have endeavored to explain the process of making them by imagining the body to move perpendicularly toward the paper, but presume that the reader, when he has in that or any other way once formed a clear conception of the relation between the body and its representation, will hardly need be told that the result is the same as if, instead of that, the body remained at rest, and perpendiculars were drawn or imagined to be drawn to the paper from every line or point in it. It is very often stated that two projections, in general, suffice to determine the thing represented. This is only partially true; it may be admitted, and will be afterward shown, that if we know beforehand all about it, we can from any two of these views build up the third. But we will find ourselves under the necessity of drawing upon a stock of information not conveyed by the two views which are already made, in order to do this; and in very many, though by no means all, cases, the whole three are requisite if we wish to be able to say to one who understands such drawings and knows how to read them, "Here is a plan which I wish you to execute."

Now, this mode of representing a body by projections is applicable to all things that can be drawn at all; we have selected the simple object shown in Fig. 144 as the first, because it is simple, and the beginner can most readily understand the principles involved by its aid. It will be observed that it is also placed in the most natural and most simple position in regard to the paper—that is, so that its principal lines and faces are in all the views parallel and perpendicular to the paper. This is done because when a line is viewed perpendicularly, it is seen in its true length, whence this position gives the actual form and dimensions of the face, which is visible in each view. In Figs. 146, 147, and 148 it is not possible to place it so that all the lines and faces shall have those relations to the paper, because they do not exist among the elements themselves in the body; but the position selected is such that as many as possible are so situated with reference to the paper, in all the views, and from the circumstances of the case the actual length and true relations of the lines can all be seen as they are, in one or the other of them. Of course it may, and does, happen that even this is not always possible; so simple a thing even as the block represented in Fig. 144 may be so placed, as a part of some combination, that it would be inclined to the paper in every view of the combination as a whole. In that case, none of the lines would be seen in their true length—none of the angles in their true size. We shall show subsequently how the representation of the object under those circumstances may be made, the proper apparent lengths of the lines determined, and their apparent relative directions ascertained. But the first step in the process will be to make a drawing of the body in such a way that all these things shall be seen as they are, in some one or more views—that is to say, if it were required to draw a rectangular block, like Fig. 144, in such an inclined position, we would first draw it as shown in that figure. The subsequent proceedings are simple enough, but they require a perfect familiarity with the principles above explained. And to realize the exact relation between the object and the drawing—to imagine by looking at the latter just how the former is placed—may require at first a little exertion. A good aid to the formation of such a physical conception, is to make a model of the proposed subject, and study it in connection with the drawing, holding it in its proper position in relation to the paper, and attentively considering how it is that each line corresponds to a part of the object. This we strongly recommend to the student: it is more necessary at the beginning, since even in the drawing of simple subjects, the difference between their representations in oblique positions, and the perspective drawings like Fig. 143, is so decided that it will be found to require some little exercise of the imagination to form clear and correct ideas of the exact relation between the object and the drawing. Any thing is legitimate which tends to aid this power of connecting the two, or, in other words, of reading a drawing; and nothing is at first more serviceable than a model for this purpose. But as we can not always have this aid, and as, moreover, it is strictly to be considered merely as an assistance, not as a necessity, the student is also strongly advised not to content himself until he can, after making use of his model, in order to clear up any doubts which he may have, lay it altogether aside, construct the drawing without it, and by looking at his work, see as clearly what is represented as though he had it in his hand.

A NEW DOMESTIC ICE MACHINE.

A NOVEL and simple machine for the manufacture of ice in small quantities, readily and cheaply, has lately been invented by M. Toselli, of Paris, and engravings of the apparatus are given herewith. It consists of a cylindrical case A, Fig. 1, suspended on trunnions, in a frame, and capable of rotation by the crank-handle shown. The cylinder is open at both its extremities, to which, however, covers are fitted. B, Fig. 2, is a nest of cylinders, seven in number, and secured between heads; no two of these vessels are of the same size, the diameters decreasing from the largest, down, in regular proportion. This assemblage of cylinders fits in the case A, and in said vessels is placed the water to be congealed. As the object is ultimately to produce a uniform lining of ice in each cylinder, it follows that the quantity of water introduced in each must be measured with accuracy. This is easily done by the tray C, in which there is a ledge, upon which the nest B rests, and is so maintained at such an angle that only a certain amount of water can be poured out of the cylinders, which amount is obviously directly proportional to the diameter of each tube, and all being parallel, to the angle of inclination.

FIG. 1.—TOSELLI'S ICE-MACHINE.

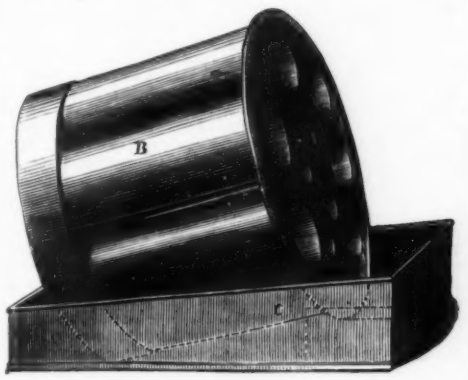


FIG. 2.

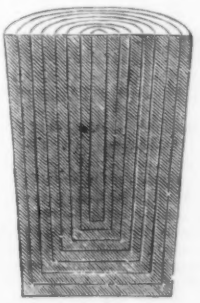


FIG. 3.

The compartments are next inserted to the case A, and the cover replaced and secured. The case is then reversed and the other cover taken off, so that a mixture of equal weights of nitrate of ammonia and water can be poured in, so as to fill the interstices of the tubes; this done, the cover is put back and fastened, and the apparatus rotated for five minutes by the crank. This period suffices to produce a moderately thick film of ice around the interior of each cylinder, and these films can be easily taken out; it remains only to fit one cylinder of ice into the other, and so to continue until all are fitted together, as shown in Fig. 3, to produce a solid block of ice weighing eleven pounds.

It would be interesting to know the amount of nitrate of ammonia employed to produce in this machine a given quantity of ice; but on this point *Les Mondes*, whence we extract our engravings and the above facts, although devoting a very diffuse article, touching upon every other imaginable attribute of the subject, is provokingly silent. An empirical formula is given, by which it is intimated the required datum can be obtained; but this solved with hypothetical values gives results out of the range of all probability.

HOW TO BUILD CHEAP BOATS.

By PADDLEFAST.

No. 4.—(Continued.)

THE TWELVE-DOLLAR ROW-BOAT—CONTINUED.

WE continue from our Supplement No. 30, page 471, the description of the construction of the twelve-dollar row-boat.

Six planks are to be bent on each side of the boat. Their widths where they cross-rib, ⊕, are as follows:

Width of plank next to keel, called "garboard strake," 4 inches.

Width of plank next to garboard strake, called "broad strake," 5 inches.

Width of plank next to broad strake, called "second broad," 4 inches.

Width of plank next to second broad, called "shutter strake," 3 inches.

Width of plank next to shutter, called "lower strake," 3.5 inches.

Width of plank next to lower, called "upper strake," 3 inches.

The curved length of each rib ⊕, from the keel to the mark on the upper end, is now divided by chalk lines into six unequal parts, corresponding to the approximate widths of the planks given above. Every other frame is subdivided likewise into the same number of unequal parts which bear the same relation to each other as on ⊕; namely, the width of the broad strakes is greatest, and the widths of shutter strake and upper strake are least, and equal to each other; but as the curved length of rib A, for instance, is shorter than that of ⊕, the subdivisions of the former are proportionately less. Those upon B are less than on A, on C than on B, etc., till the widths upon the stem are approximately as follows:

Garboard strake	2.40	inches.
Broad "	2.88	"
Second broad "	2.88	"
Shutter "	1.78	"
Lower "	2.25	"
Upper "	1.78	"

The stern ribs, 1, 2, 3, are also marked with gradually decreasing widths, which on the stern are:

For Garboard, about	2	inches.
" Broad "	4.15	"
" Second broad "	4.15	"
" Shutter "	2.5	"
" Lower "	2.5	"
" Upper "	2	"

The widths being marked on bow, stern, and frame ⊙, amidships. The intermediate ones may be most conveniently determined by bending a thin narrow strip of wood upon the ribs, running from a certain width on the stem—for instance, to the corresponding one on rib ⊕.

The first planks bent are the pair of upper strakes. To determine their shape, closely bend a board nine feet eight inches long, six or more inches wide, ¼ inch thick, upon the ribs (Fig. 46), and at the side of every rib, where the width of upper strake is marked, bore a gimlet hole through the board. We shall hereafter call this the curve board.

The board intended for the upper strake should be white oak .5 inch thick, and considerably wider than the width of the strake to allow for the curve. Lay the curve board upon it, and bore holes in it through the holes already made in the curve board. Saw out the strake on gradual curves passing through these holes, and plane the edges. Lay this upon another oak board and mark out the other strake from it. The length of these strakes should be such that they project one or two inches beyond the stern when they are bent.

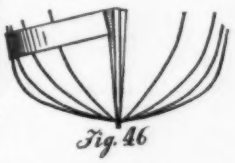


Fig. 46

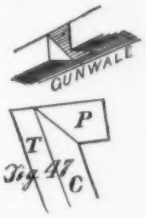


Fig. 47

The bow ends of these planks must be cut slightly bevel to fit the grooves in the stem-piece. The precise shape the builder may easily determine by laying the end against the stem.

The best fastenings for the planks throughout are copper rivets, but if cheapness is an object, the builder may use galvanized inch nails with countersunk heads.

Steam the upper strakes for about twenty minutes, bend one at a time to its place by clamps, first nailing the bow end to the apron by two 1-inch nails, next fastening to rib E, then to D, to C, and so successively using two rivets or nails to each rib, and holding an axe-handle behind to deaden the blows of the hammer. Two 1-inch nails in the stern fasten the stern end. Nail on the opposite strake.

The "gunwales" are two thick white oak strips bent upon the upper edge of the boat, one on each side. The gunwale is placed inside the upper strake. The ribs terminate under

X in notches, as seen by its cross section, Fig. 47, in which P is the gunwale, C is the rib, and T the upper strake. The dimensions of the gunwale are: length, about 10 feet; width, 1 inch; thickness, ¾ inch. The ribs are first sawed off with a bevel of about 45°, leaving the extreme bevelled ends flush with the upper edge of the upper strake; the gunwale is steamed and bent to conveniently mark the notches, cut as shown in Fig. 47 for every rib, and then bent to its permanent position, with one of the broad sides uppermost and flush with the upper edge of the upper strake. The gunwale is secured at bow, as seen by Fig. 48, in which N N are the upper strakes, G the upper end of the apron, P P the gunwales, and O a small white oak knee bolted to apron and nailed to the gunwales. The width of each gunwale is here reduced by a gradual taper to about ¾ inch. Fig. 49 shows the aft end of one gunwale; S is the stern, N the upper strake, P the gunwale, and O a white oak knee with arms about 5 inches long, nailed by two nails in each to stern and gunwale. At intervals throughout the length—for instance near every rib—drive a nail through the upper strake into the gunwale. The gunwale is not fastened to the ribs.

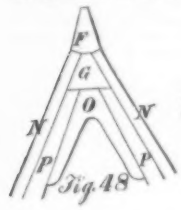


Fig. 48

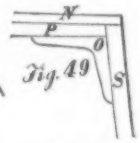


Fig. 49

Fig. 50

The suggestions for bending the upper strakes apply to the other planks also. In cutting the end of a broad bevel to fit the stem rabbit, make the bevel greater than apparently necessary, as it is reduced by bending. Fig. 50 shows the proper shape, which when bent fits close. All the planks but the upper strakes are white cedar, and hence need not be steamed over ten minutes. Over-steaming should be avoided. Of course the seams between the planks should be as tight as possible. Knock off all the braces, detach the keel from the stock—that is, the board on which it previously rested; then invert the boat and bend the boards upon it in the following order:

(1) Lower strakes; (2) garboard strakes; (3) broad strakes; (4) second broad strakes; (5) shutter strakes.

Fig. 51 presents one end of the "thwart" or cross seat. W is the "rising," which follows the curve of the edge of the

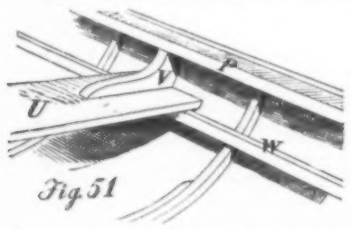


Fig. 51

boat, is depressed 4½ inches below it, and runs from rib E to rib 3. The thwart is nailed upon the rising, crosses it, and fits close against the outside plank. The knee V is nailed to the upper strake and to the thwart.

Width of rising	1.5	inches.
Thickness of rising	0.5	"
Width of seat	7.0	"
Thickness of seat	0.5	"
Distance of forward edge of seat from bow	4	feet.
Length of knee on thwart	6	inches.
Thickness of knee	0.75	"

Material of thwart, white cedar or black walnut; rising, white cedar; knee, white oak. The rising is bent against every rib and nailed to it.

Fig. 52 is an amidship cross section, in which the heavily shaded portion shows the "ceiling," that is, a flooring on the

Fig. 52

bottom, inside. It consists of three boards nailed to the bottoms and running nearly the length of the boat. The width of the middle board (6 inches) is such that it is raised above the horizontal surface of the bottom. In this position, supported only at each edge, it would split when stepped on; hence it is supported by a cleat on the under surface, resting on the bottom. It is loose, so that it may be removed for bailing. The boards *m m* are about 4 inches wide, and with the middle board ½ inch thick.

Though this boat is intended for one person, it is capable of carrying two; so, if the builder desires it, he can make a stern

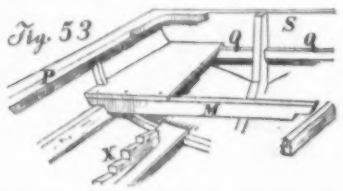


Fig. 53

seat, as in Fig. 53. M is a cross piece nailed upon the rising; horizontal cleats, Q Q, are nailed to the stern 4 inches below the top. The seat boards are nailed upon the cross-piece and the cleats. The grain of the seat-boards is parallel with the

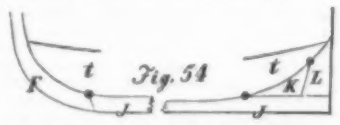


Fig. 54

keel. X, same figure, is a notched stick, one of which is placed on each side of the boat to receive the "stretcher." The latter is an oak stick placed crosswise, against which to brace the feet in rowing.

In Fig. 55 a rowlock is represented elevated above the gunwale P by an iron strap secured to the gunwale by copper

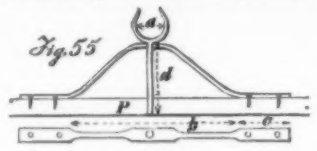


Fig. 55

screws. The shank of the rowlock passes through holes in the strap and in the gunwale.

Dimension	*a*	2½	inches.
"	*b*	8	"
"	*c*	2½	"
"	*d*	4	"

The middle point of the rowlock is 11½ inches abaft the after edge of the seat or thwart. Oars, 6 feet long, preferably of ash. Those sold are far superior to home-made.

Caulk with waste cotton and putty. To prevent leaking at the junction of the stem F with the keel J (Fig. 54), a half-inch auger hole is bored through to the other side in this joint at the edge of the garboard strake *t*, and a plug inserted. At the stern, two others plugs or "stopwaters" are driven in the joints shown.

The boat may be either painted or varnished, or the outside painted and the inside varnished. A suitable varnish is coach body, or gum-shellac.

In the next number a much larger row-boat will be described.

THE OPHTHALMOSCOPE.

The ophthalmoscope is an apparatus which allows of the examination of the interior of the eye, and is therefore of the greatest use when in the hands of the physician, not merely for the examination of maladies of the organ, but for the diagnosis of a certain number of general affections.

Every one knows that the pupil of the eye, except in albinos, is black; the retina on the other hand, which is spread over the interior and rear of the eyeball, is red. Reasonably, there-

THE OPHTHALMOSCOPE.

fore, it would appear that through the crystalline contents of the ball we should see the red retina whenever, for instance, we look attentively into our own eyes in a mirror. It is well known that for a body to be visible (self-luminous bodies not being considered) it must reflect rays of light to the eye of the observer. Nearly all bodies, the retina included, diffuse the light they receive, and hence, in order that they may be seen, it suffices to expose them to a source of light, and interpose no screen between them and the eye. But these easily realized conditions are often contradictory. Take for instance a hollow pen-holder, and looking into the open end try to see the part which closes the other extremity—the bottom, if held vertically. Whatever position we may give the tube, the effort will prove unavailing. The reason is, that in order that the bottom should be visible, it must receive direct rays of light, and reflect the same back to the eye. It is therefore necessary to place the lamp, for example, whence these rays are emitted on the prolongation of the axis of the tube, since in any other position the sides will intercept the rays; moreover, and for the same reasons, the eye of the observer must likewise be placed in the same straight line. Now the lamp can not be placed behind the head of the observer, for then its light would be cut off; nor can it be located between his eye and the tube, for then its superior brightness would dazzle the organ, and prevent its seeing any thing else.

An analogous effect may be produced by boring a small hole in the side of a closed box. No matter in what positions lamp and eye be placed, the aperture always looks black. Still the lamp sends a ray of light through the hole, and il-

TUBE OPHTHALMOSCOPE.

lumines a point inside, but to see that point the lamp and eye and hole must, as before, be on a right line—an impossible condition to realize.

The eye up to a certain point is comparable to the box just mentioned, but the pupil or the aperture through which the retina is seen has quite a large area relatively to the diameter of the globe. The retina, however, can not be seen because the lenses of the organ produce a converging system of rays, which act very nearly as if coming from the bottom of a tube as already considered.

In an albino, however, the membrane which surrounds the eye is not opaque, and allows a certain quantity of light to pass. The retina is then illuminated otherwise than by rays which traverse the pupil and crystalline matter, and the observer sees the rear of the eye in its proper color.

We can now explain the principle of the ophthalmoscope, the above conditions being understood. The luminous rays which enter the eye to illuminate the retina have the same direction as the rays which, emanating from the retina, pass from the eye to the observer. It is clear that it is the direction of these rays, at the moment when they traverse the transparent cornea in one or the other direction, that it is useful to be considered.

In order to attain the desired result Helmholtz first used a plate of glass which reflected the light of a lamp at one side into the retina. From this the rays again reflected, returned over the same road, and part of them, enfeebled, it is true, in intensity, passed through the glass to the eye of the observer. In order to stop all but useful rays, and to augment the number of these, a dark room is employed for the examination, and the lamp is inclosed in an opaque cylinder having a single aperture, in which is located a bi-convex lens, which converges a large number of rays.

This device, however, resulted in such extensive loss of light that the rays of light are now reflected into the retina by a finely-made concave mirror of metal. In the centre of the mirror is made a small aperture, through which the observer receives into his own eye the reflected rays from the retina of the patient. This arrangement admits of a complete and detailed study of the organ, and the mode of using the instrument will be plain from Fig. 1. The lamplight is shaded from the patient on the left, and reflected from the mirror in the hand of the observer on the right through a lens held by the latter, and then into the patient's eye. An arrangement of the device in tube form is shown in Fig. 2. Dr. Gerard Teulon has recently made an important improvement in the ophthalmoscope, by constructing it so that the observer can use both eyes. This allows of parts sunken or in relief on the retina being properly recognized, and prevents many of the errors incident to monocular vision.

HEADACHES FROM EYE-STRAIN.

By S. Weir Mitchell, M.D., Philadelphia.

Dr. Mitchell avers that the general profession are not fully alive to the need of interrogating the eye for answers to some of the hard questions which are put by certain head symptoms, since many of the patients treated successfully by the correction of optical defects never so much as suspected that their eyes were imperfect. He submits the following propositions:

1. That there are many headaches which are due indirectly to disorders of the refractive or accommodative apparatus of the eyes.

2. That in these instances the brain symptom is often the most prominent, and sometimes the sole prominent symptom of the eye troubles, so that while there may be no pain or sense of fatigue in the eye, the strain with which it is used may be interpreted solely by occipital or frontal headache.

3. That the long continuance of eye trouble may be the unsuspected source of insomnia, vertigo, nausea, and general failure of the health.

4. That in many cases the eye trouble becomes suddenly mischievous, owing to some failure of the general health, or to increased sensitiveness of the brain from moral or mental causes.

The form of head-pain caused by eye troubles is rarely of the nature of megrim, and, as it soon disappears when the eyes are corrected, is lacking, happily, in the obstinacy of that distressing malady.

A number of cases are cited to substantiate the above propositions, some of which we epitomize:

Case 1. A prominent merchant first consulted Dr. M. late in the winter for pain in the upper spine and occiput. In the previous autumn, only writing at first, and then later reading, and any near work caused pain. Finally, an over-sensitive state supervened, when a few moments spent in writing would give the patient a creeping sensation up the spine and through the back of the head, followed by giddiness and severe pain. The treatment adopted proved of no avail. Subsequently, the patient consulted an ophthalmic surgeon, who found the vision defective, owing to an optical defect. The proper corrective glasses raised the sight above the average standard, and on using them habitually, the distressing symptoms quickly disappeared. The use of the glasses, without other means, restored the patient to perfect health again.

Case 2. The patient, an accomplished and energetic single lady, aged 30, with heavy household cares, and additional literary work, began some five years previously to have evening headaches, pain in the back of the head and neck, sense of extreme fatigue, etc., if she persisted in exerting her mind in reading or writing, though without any sense of trouble in the eyes. At last she became feeble, nervous, and anæmic, sleeping little and having almost constant headache, and the use of the eyes caused pain in them and a sense of fatigue. For nearly two years Dr. M. was at fault, but at length referred her to a specialist, April 19, who found the sight impaired, owing to an optical defect, and prescribed the corrective glasses. On May 26, the headache and sleeplessness had gone, patient could read and write without pain; used her glasses constantly. The relief of the ocular defect sufficed to restore the patient.

Case 3. Patient, a well-nourished intelligent lady, with intense and frequent headaches, usually frontal, without sense of ocular fatigue. Long after the headaches had begun, reading was found to aggravate them, and only rarely to cause fatigue or pain in the eye itself. The correction of an optical defect by suitable glasses gave almost immediate relief, and ere long put an end to the headaches.

Case 4. No eye-pain, but violent headache, described as neuralgic, with nausea and vomiting; optical defect present; prompt and absolute relief by correcting glasses.

Case 5. History of headaches, and later on of vertigo with insomnia; the subjective symptoms subsiding on wearing correcting glasses.

Case 6. Patient, a lawyer aged 51; a long lifetime of active work and constant use of the eyes, but no trouble until one night of intense anxiety gave rise to threatening but brief cerebral symptoms, which at once seemed to make the use of the eyes painful. The cerebral symptoms (vertex headache, excitement of mind, etc.) were such as to point rather to cerebral troubles than to the eyes as the cause of distress. On neutralizing an optical defect, by proper glasses, entire relief was afforded. A good example of the way in which a permanent unfelt defect is lifted into evil influence by some brief but potent disturbance of the cerebral centres.—*The American Journal of the Medical Sciences.*

TEMPERATURE OF THE INTERIOR OF THE EARTH.

From observations made on the Well of Sperenburg, near Berlin, M. Mohr concludes that at the depth of 5170 feet the increment of heat must be nil. A similar decrease of the increment of heat has been observed in the Artesian Well of Grenelle. Hence M. Mohr draws conclusions unfavorable to the Plutonian theory.

HOUSE DRAINAGE.

By JAMES R. WILLETT, Architect.

It is laid down in the books to disconnect the drains inside the house from those outside by building a grating or trap outside of, and close to the house wall, and letting the drains from inside discharge into it above the ground; this is generally impracticable in cities, and even when it can be done the trap is almost sure to freeze up in very cold weather. I therefore prefer to run the main drain direct to a flue (made of drain pipe built into a wall), which leads above the roof, thus giving the sewer ample vent without even the intervention of a trap, and relieving the house pipes of any back pressure from sewer gas.

Catch basins when they communicate with pipes leading up through the roof, as they should do, ought not to be trapped so as to prevent the escape of the gases up the pipe. Air and

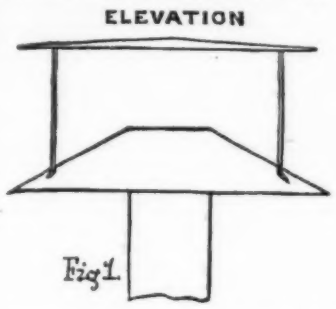


Fig 1.

gas from sewers are warmer, in cold weather, than the atmosphere, and their escape will tend to prevent freezing of the pipes. Down spouts and other pipes which communicate with the sewer without the intervention of a trap, can be recognized in cold weather by the vapor which arises from their openings in the roof.

The books say that soil pipes should be of lead, but my experience leads me to say that they should be of cast iron for the following reasons: I have seen leaden pipes honeycombed so as to be a mere sieve; long lengths of lead pipe, even when carefully put up, are apt to sag and tear asunder in the course

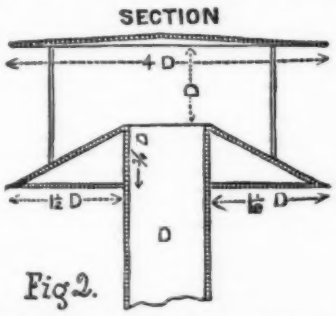


Fig 2.

of time, and workmen can and will, in order to save labor or to pass through a narrow space, compress lead pipe so that it is liable to choke, all of which may be avoided by the use of iron pipe.

All soil pipes (and waste pipes too) should be capped by a ventilating top, the best of which, in my opinion, is the old Emerson ejector, Fig. 1, but it should be made as large or larger, and of the pattern shown in the sketch. They are generally made much too small. The rain cover should be

Fig 3.

very nearly flat, with only just enough fall to prevent water lodging and rusting through, when made of iron. D = diameter of the soil pipe. The dimensions are given in diameters. The waste pipes from safes should also go above roof.

Be sure that the branch pipe from a trap goes horizontally, or very nearly so, to the main waste pipe, as shown in Fig. 2; for this reason it is best generally not to use Y joints in vertical pipes, as they will probably cause the longer leg of the

Fig 4.

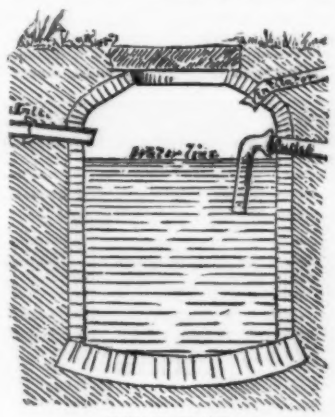
siphon to be on the side of the trap toward the waste pipe, as in Fig. 3, which will cause the water to be siphoned out of the trap.

Bell traps, or any trap that can be readily opened and left open, should not be used, especially inside of houses. If possible, the soil pipes should run up by a steam pipe, chimney, or other place where it will be heated, which will help to make it draw.

I have tested water closets when there was no water in the traps, the soil pipes of which were put up as described, and I have always found that the flame of a candle would be drawn *into* the trap, thus showing its effectiveness.—*Engineering News.*

GREASE TRAPS.

THERE are various forms of grease traps which serve a good and useful purpose. The best that has come to my notice is that shown in the accompanying diagram:


GREASE TRAPS.

It is made of well cemented brick-work, and need not be more than from four to six feet in diameter, according to the liberality with which water is used in the house. It must be absolutely water-tight. It should be placed close to the house, so that there shall be the least practicable length of drain pipe to accumulate grease—allowing it to flow hot into the trap where it will float at the surface of the liquid, at a point at least a foot above the mouth of the bent outlet pipe. Any solid refuse will have ample room at the bottom of the trap, well below the outlet. I have not found it necessary to clean out my trap (made in this way) more than once a year. Indeed, the solid deposit, being organic matter, decomposes and forms ammonia, which helps to dissolve the grease and make it soluble, so that both the deposit and the scum are constantly being washed away. It would be well to run a rain-water spout into this trap to cleanse it, and if it is not near a window, its best ventilation would be by a grating in its top stone.—*Waring's Sanitary Drainage.*

COST OF A BUSHEL OF MEAL.

WE had an impromptu farmers' club at our house, a few nights ago. The subject was the fertile one of corn; and although such a text might have carried us from the seed-corn to the field, through germination, growth, and harvest, to the corn-house, or from the bin to the barn, and thence through the animal to the dung, and from the dung to the soil again, to be reformed into corn, yet it did none of these; but we were having a desultory talk, after the way of farmers, as to the methods of treatment advocated by different people.

The audience was a good one: five Massachusetts farmers, and one Illinois breeder and farmer of repute, W. R. Duncan, of Towanda; and the farm practices of the East and West were being brought under contrast. Our eastern ways were considered rather petty and trivial, as compared with the wastefulness of the West; while the wastefulness of the West, as seemed to us, was being explained as but apparent rather than real, and that differences of farm treatment arose from the different conditions which locality, markets and habits made necessary. We were not advancing very much in our discussion, when the startling question was asked by a Massachusetts man as to what was the cost of a bushel of meal to the average New England farmer, charging labor at $1.50 a day. The query not being readily answered, Mr. Ross proceeded to give his idea as below:

Suppose the corn cut and stooked in the field. To husk this corn will cost, on the average, 10 cents a basket, or 20 cents a bushel. Binding will cost 2 cents. To shell it adds 3 cents more. The farmer usually takes half a day to go to mill, and carries about ten bushels; this is 7½ cents a bushel. The miller takes 8 cents toll, and there is a shrinkage in grinding. We thus have 20 cents + 2 cents + 3 cents + 7½ cents + 8 cents = 40½ cents.

We were confounded, and felt like denying. Our first objection was, that husking cost us but 10 cents instead of 20. We were met with the answer that if the cost of horse labor was added, this would make the total about the same, despite our objection. We then said the farmer should carry 40 bushels to mill instead of 10, and to this it was replied, "But he doesn't." We concluded, therefore, neither to admit nor deny, but to get time for further thought by asking a puzzler in our turn, in the manner of a Yankee. So we launched our bolt, as we supposed, by the query, "What are you going to do about it?"

The reply came short and to the point. "Feed the corn to your cattle in the husk and on the stalk, and save your forty cents, for this saving will more than compensate for the waste in the assimilation, by the amount of corn over meal." "What do you *know* about this course?" we quickly rejoined. "I fed forty acres of corn last year in this way, and fatted cattle thus at a profit."

Then Mr. Duncan spoke: "I have studied the problem of how to feed corn in the best way for years, and I completely agree with the speaker, that when corn has to be taken to the mill and ground, and returned, the enhanced cost is more than the material will bear. But you can derive the benefit of the grinding at a cost which will leave a profit, by steaming or cooking your corn until you can mash the kernel between your thumb and finger." But what if you do not believe in steaming? How about feeding the corn whole? The reply was, that what corn passed the cattle was picked up by the pigs and that the waste was far less than was generally supposed. At any rate, less than the cost of grinding.

These were new ideas to us, and seemed worthy of careful discussion, and we have felt grateful for this club meeting ever since. There is much in these observations that is true, and their consideration readily led us into new currents of thought. The benefit of the practice of steaming food is now an open question in New England, and we usually go to the expense of grinding our corn, and then steaming the meal. Should we save the cost of grinding, might not this saving cause the scales of opinion to be turned?

These farm questions are not so much whether any one practice of a series be profitable, as whether the total of the process be profitable. If there is a waste in digestion, may not that waste be more than balanced by a saving in labor? It seems to us that many farm customs might well be investigated on a general basis.—*Scientific Farmer.*

POTATOES—LEVEL CULTURE.

FROM a recent article in the *Utica Herald*, on potato culture, we glean the following:

"There are many objections to the present method of culture, though it can not be denied that it yielded abundant harvest. The best known method of ridge or hill culture is as follows: Select a strong, loamy soil, which has been in cultivation at least one year; fertilize thoroughly, if in the hill, mingle the manure with the soil; mark in rows 3 feet apart; hoe twice, the second time forming a continuous ridge. This method will yield, in favorable years, at least 250 bushels per acre. This—and planting in hills 3 feet apart each way—are the methods practised by nine tenths of our farmers. But there seem to be some objections to them. All rain and moisture must necessarily soak quickly through the ridge, furnishing but temporary nourishment. The heat of the drouth soon dries out of the ridge, and renders its soil lifeless. We have observed that the ridges yield more potatoes when they are shaded somewhat by weeds, and while a weedy potato-patch betokens a slovenly farmer, there are many reasons for belief that weeds protects the potato ridge in seasons of drouth. The potatoes are also liable to exude from the hill and to be exposed to the sun, an exposure which ruins them.

"The natural location of any plant for growth is below the level of the ground, and this is especially true of the tuber. A potato hill built above the level of the ground is not the natural receptacle for the seed. Nevertheless, copious and profitable crops have thus been produced. The chief question is, Can they not be increased? There have been no extended experiments in level culture. The chief objection urged against it is the difficulty of digging. The seed must be planted at the depth of about 6 inches, and it is not possible to dig the crop with the ordinary 'hook' so conveniently as when it grows in hills. But there is no reason why the deep-laying tubers should not be ploughed out or otherwise brought to the surface by machinery. We believe this subject deserves a portion of the attention of potato-growers. It is novel to many of them; and a corner of the field devoted to a test might yield results which would be valuable."

PLOUGHING IN RYE.

ON the farm of President Clark at Amherst was a poor, gravelly field of six acres, which yielded only one half ton of hay per acre. Last fall the field was ploughed, and one ton of rectified Peruvian guano applied to the whole and harrowed in. The piece was then sowed to winter rye, resulting in a crop, this year averaging nearly five feet in height when ploughed under, and which good judges estimated would yield, if harvested, thirty bushels of grain per acre. But President Clark is one who generally induces Nature to produce about as he wills, by following out the principles she has herself laid down. The soil here was lacking in organic matter as well as in plant food, and this was the readiest means of supplying the deficiency. The rye was ploughed under just before blossoming, though on general principles the better way is to turn it under when nearly ripe, at the time when the crop has taken into itself the largest attainable amount of atmospheric and soil matters. A large size, Holbrook's swivel plough was used, ploughing to a depth of seven inches, and was followed by a sub-soil plough stirring the soil seven inches deeper. Next autumn another ton of rectified guano will be applied to the six acres and harrowed in, and the field seeded to grass and winter rye. Thus the lot will be quickly and effectually supplied with a large amount of organic and mineral elements of plant food. If allowed to mature, according to the estimate, the crop ploughed in would add to the soil of available plant food about 227 lbs. of nitrogen, 200 lbs. of potash, and 122 lbs. of phosphoric acid, which would nearly equal in value the two tons of guano. Perhaps the chief value to the land, however, is in the organic matter derived from the air, added to the soil—a value which can hardly be estimated.—*Scientific Farmer.*

[St. Paul (Minn.) Pioneer Press.]

A NEW WHEAT DESTROYER.

WHAT has heretofore been thought a chinch-bug, destroying wheat on the Southern Minnesota Railroad, now proves to be a fly. People who have been over the Southern Minnesota Railroad say there is a new insect at work on the growing crop of wheat along the line, especially where it has been dry. Although the last rain has dispelled the fears of a drought, the fly has gone to work vigorously, and all through the fields patches of growing wheat present the appearance of having lost life and verdure. It turns yellow, withers up and dies. The flies seem to work near the root, and draw the sustenance out of the stalk. Whether they will continue in their ravenous course remains to be seen. If they do, whole fields will not yield a return of seed. From latest advices we learn that the ravages have somewhat ceased since the recent rains, which have reached nearly the length of the road, though it is too soon to tell whether they are extinguished. The sun has not shone to warm them up.

WATER-CRESS IN THE MATERIA MEDICA.

IN a recent letter from the Paris correspondent of the *British Medical Journal*, he writes:—

"In the vegetable kingdom there are several substances that possess the double quality of food and medicine, and as such might be usefully employed in therapeutics. Among the vegetables that possess the valuable property referred to, I may mention the water-cress. According to an analysis by M. Chatin, Director of the School of Pharmacy of Paris, and present President of the Academy of Medicine, water-cress contains, 1, a sulpho-nitrogenous essential oil; 2, a bitter extract; 3, iodine; 4, iron; 5, phosphates, water, and some other salts. As medicine the water-cress has been vaunted for its efficacy in all cases in which the digestive organs are weak, in cachexia, in scurvy, in scrofula and lymphatism; it has even been prescribed as a cure for phthisis. The medicinal principles which it contains are more or less abundant according to the culture or maturity of the plant. Thus when the plant is in flower they are in greater quantity in the plant than before that condition; the essential oil increases according to the quantity of the sun's rays it receives. The proper culture of the plant develops in it the bitter and

tonic principles, and the phosphates will be found in proportion to the manure employed. Finally, the quantity of iron will depend upon the richness of the water in which the cress is planted.

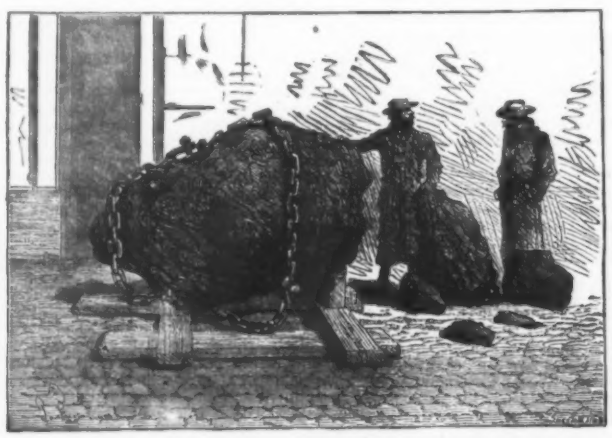
"As food, water-cress ought to be used in its green or uncooked state, in the form of salad or without any seasoning. Where a large quantity is to be taken, the juice alone of the fresh plant is recommended. This is obtained by expression in a mortar; it is then filtered and administered in doses of thirty or forty ounces a day. The juice contains all the active principles of the plant. M. Dupuy, a pharmacien, keeps a supply of the juice in a concentrated form, and as obtained from the seeds of the water-cress, a resinous yellowish-looking substance, to which he has given the name of "cressine." This, however, is not yet introduced into practice, as it requires further study and experience before it can be classed among the immediate principles or other medical substances. Water-cress enters largely into the composition of the 'sirop antiscorbutique' of the French Pharmacopœia, which is commonly prescribed in scrofulous and scorbutic affections."

NEWLY-DISCOVERED ANTIQUITIES.

SOME late discoveries on the high ground of the Esquiline and Viminal hills, and near the premises of the railway station at Rome, may class, if not among those of artistic, certainly among those of high historic interest; for this newest treasure-trove comprises objects that may be referred to antiquity prior to the founding of Rome. Such is the apparent age of sundry terra-cotta vessels, weapons, and domestic utensils found near the elevation called Monte della Giustizia, part (if not the whole) of which belongs to the Agger of Servius Tullius. Still more curious is one object dug up together with several others of the class and character above-named: a vase formed of the clay of the Esquiline, in which it lay embedded, and evidently wrought with the hand, not with any instrument; especially remarkable on account of the archaic inscription, consisting only of three mysterious letters at the bottom—which it has been assumed *may* be the most ancient specimen of writing on any monument yet found in Latium. Another vase with two handles among those things recently dug up is of the same clay and wrought in the same manner, this bearing signs of high antiquity in the rude *graffiti* designs adorning it—so uncouth, indeed, as scarcely to be called "designs," and to seem like attempts made in some remote period when neither ornamentation nor geometric figures were known or could be applied for any artistic purpose by the authors of such barbaric manufacture. Numerous bronze objects were found near the Monte della Giustizia in the recent *scavi*—one of the Imperial period—not of such historic value as the terra-cottas; though several medals, particularly those of the Antonine Emperors, may be signalized among the treasure-trove of this more familiar description.—*Academy*.

PRECIOUS STONES IN BRAZIL.

A VALUABLE paper on the "Valley of the Tibagy, Brazil," by Mr. Thomas P. Bigg Wither, A.I.C.E., was lately read before the Royal Geographical Society. Mr. Wither visited the valley in 1874, when engaged in surveying for a line of railway. In the immediate vicinity of the Tibagy, he informs us, there are large deposits of clays and gravels, in which latter diamonds were first discovered about 30 years ago, and it was this discovery that led to the formation of the present town, which, though the diamond mines are now no longer worked, still gives evidence of prosperity. The working of these diamond mines was abandoned some four years ago, not on account of their exhaustion, but because the depth which the diamond-yielding stratum had then reached below the surface made their further operations no longer profitable with the limited resources at the disposal of those interested. Statistics obtained on the spot, and verified where possible from independent sources, and a careful examination of the mine itself, convinced Mr. Wither that though abandoned for the present it is yet capable of being worked with exceedingly profitable results. On resuming his journey from St. Jeronymo, and having passed the river of that name, Mr. Wither found that the geological formation underwent a change. In the place of sandstones and porphyries a reddish-brown amygdaloid rock, with its numerous little cavities lined with the green mineral chlorite, forms the body of the hills, and continues to be the dominant formation down to a point some distance below Jatahy, whence down to the Paranapanema sandstone, split up in all directions by dykes and large masses of greenstone, again takes possession. This amygdaloid formation extends in a south-westerly direction as far as the Jvahy Valley, where it assumes a somewhat different character, the cavities in its substance increasing greatly in size,



HUGE METEORITES FROM GREENLAND.

and often containing agates of 4 and 5 ft. in diameter, which, when broken open, are found to be lined with brilliant and well-formed crystals of amethyst, and other varieties of quartz. These are the stones which some 250 years ago raised great expectations amongst the inhabitants of the province, a great number of them having been found in the bed of the Jvahy river by a party of so-called explorers (Mr. Wither said they were in reality slave-hunters), and by them mistaken for sapphires.

A NEW MICROSCOPIC SLIDE.

By M. ERNEST VANDEN BROECK.

Communicated by Professor RUPERT JONES, F.R.S. Read before the Royal Microscopical Society, 1876.

THE great inconvenience with the ordinary slides is that in general there is no possibility, without breaking or squeezing the preparations, or at least damaging the label and glass cover, of adding to the mounted specimens or altering the preparation at all.

With the slides uncovered with glass there are the inconveniences of dust and damage to the specimens.

For good results the observer ought to be able to study the preparation by both transmitted and reflected light, and to be able to apply the object-glass at very short distances.

The following plan of preparing slides meets these difficulties. Seen from above (Fig. I.), the new slide does not differ from ordinary slides; but turned over (Fig. V.) it shows a different principle of construction altogether.

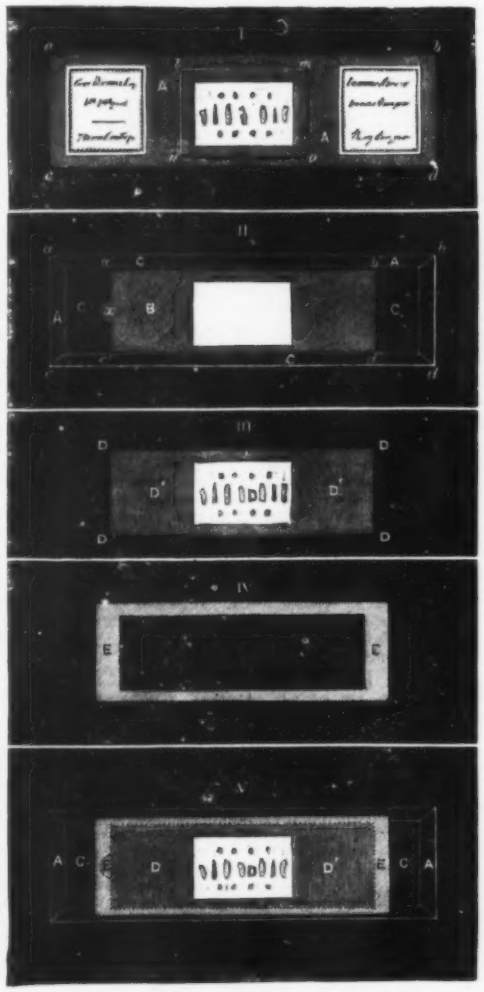


Figure II. represents a piece of cardboard, or thin wood, B, of the size *a*, *b*, *c*, *d*, perforated in the middle. On the edges of this opening (which may be either round or square) is gummed a glass cover (Fig. I., *l*, *m*, *n*, *o*), and over its edge is gummed a strip of paper (red or blue), A, which is folded over below, Fig. II. Underneath the card B is gummed the card C, with its opening *a'*, *b'*, *c'*, *d'*. Fig. II. Slips of ordinary microscopic glass are cut a little smaller than the opening *a'*, *b'*, *c'*, *d''*; see Fig. III., D. With a little brush I then coat the glass slips with a thin layer of gum-arabic mucilage mixed with a little glycerine. Afterwards I cover the glass D with the paper D', which has an opening corresponding with that of the glass cover. (The frame of paper D' is to prevent the glass D sticking to the surface B when the glass slide is placed, with its Foraminifera, or other objects fixed on D, in the cavity *a'*, *b'*, *c'*, *d'*, of Fig. II.) Then I have little oblong frames of very thin paper, gummed, Fig. IV., E, which are to fasten down the glass D, and keep it in the cavity *a'*, *b'*, *c'*, *d'*, and exclude dust. When finished, the slide has the appearance of Fig. I. above, and Fig. V. on its under side; and it can be used with either transmitted or reflected light under different circumstances. For extra large specimens, the perforated cardboard or wooden slips B may be doubled. To rearrange or add to the specimens, wet with a small brush the thin silver or tissue paper E, which is then readily detached. With the nail, for which a notch is left at *x* in Fig. II., the glass can then be lifted, and changes made in the preparation; after which, by replacing the glass D in its cavity *a'*, *b'*, *c'*, *d'*, and gumming on a new frame of thin paper, the slide is renewed, by this really simple, though apparently complex method.

The pieces of cardboard and wood, as well as the little frames of thin paper, can be obtained ready made, and already gummed as far as necessary, so that numbers may be put together in a little time.

HUGE METEORITES FROM GREENLAND.

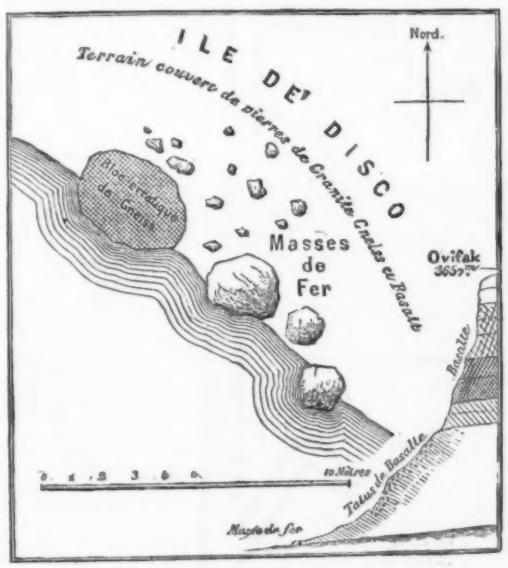
IN 1870 Professor Nordenskjold discovered at Ovifak, Disco Island, on the western coast of Greenland, a number of masses of metallic iron, consisting in three huge blocks, respectively 44,000 (Fig. 1), 20,000, and 10,000 pounds in weight, accompanied by numerous smaller pieces. Impressed with the scientific interest attaching to these specimens, M. Nordenskjold succeeded in inducing the Swedish Government to send a couple of vessels to secure them, and by dint of great exertion they were loosened from their resting-place on the beach. The location of the masses is shown in Fig. 2, from which it will be seen that they were grouped quite closely together. Behind them rose a declivity of basalt fragments, and then a steep precipitous basalt cliff over a thousand feet in height. By means of huge rafts the blocks were after some months' labor transported to the ships, and by the latter brought to Sweden. There an analysis was made of the metal, the presence of nickel and cobalt was recognized, and the chemists pronounced the masses to be of extra-terrestrial origin.

From time to time, as our readers are aware, masses of mineral matter fall upon the earth, accompanied with brilliant manifestations of light and great noise. Some of these masses have hitherto been recognized as composed of metallic iron. In addition to the fact that such large quantities of pure metal are *not* found on earth, the meteoric metal is distinguished from that industrially produced by the presence of nickel and cobalt; so that when these metals were detected in the Greenland blocks, as already stated, the chemists were inclined to ascribe to them an origin in stellar space: still, celestial origin was not to be predicated without more certain proof. According to the analyses of M. Daubrée, the rocks containing native iron at Onfak belong to three types. The first consists in a blackish rock, resembling certain graphitic cast iron, and susceptible of polish. Its fracture is lamellar, though the faces of the cleavage do not show any regular disposition or crystalline system. The second type also has a color and brilliancy resembling ordinary wrought iron, but when the rock is pulverized it separates into two distinct portions, one of which becomes reduced into fine powder, while the other remains always in fine scales. Finally, in the third type, the metallic substance instead of being continuous appears in grains in a stony mass; the latter is silicious, and of a dark green color.

These rocks are equally distinguishable by their aspect and by their composition from the types of meteorites hitherto known. On the other hand they offer many points of similarity among themselves. Their crystalline state and the presence of oxidulated iron seem to ally them to basalts and dolerites. Even the existence of native iron, which at first sight seems to constitute a profound distinction, may be considered as a connecting link. In fact, if it is true to say that meteoric iron is not counted as a species among terrestrial rocks, it must likewise be admitted that it is found in the nodules in many of the latter.

It will be observed from our map that the Onfak shore is shut in by a high range of basaltic rocks. These contain meteoric iron in extraordinary quantity, which presents itself under the form of rounded grains of all sizes, possessing the same chemical composition as the large detached blocks. Moreover, it has been noted that fragments of the same basaltic rock were still adherent to the exterior, and even embedded in the interior of the isolated masses.

To explain this on a hypothesis of extra-terrestrial origin it would be necessary to suppose that the fall of the meteorites occurred while the basalt was in a state of pasty eruption. But this the form of the iron nodules negatives.



THE GREENLAND METEORITES.

In the interior of the globe, it is believed that there exists a nucleus in which iron predominates. Now, asks *La Nature* may we not consider these supposed meteoric masses, which hitherto have caused such excitement in the scientific world, to be but portions of that internal nucleus? In other words, it is suggested that they are merely of volcanic origin. If this hypothesis be substantiated it becomes of importance in that it indicates the existence in the earth of vast quantities of nickeliferous iron.